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ABSTRACT

Presented is a resource book to be used with instructional kits for elementary school science students, grade 4. The individual units at this grade level are based on curriculum which has been developed by the National Science Foundation in the 1960s and revised to meet student and teacher identified needs in Anchorage, Alaska. Four units are included within this guide. Each unit lists kit and non-kit items, supplemental materials, teacher background information, and proposed schedule. Worksheet masters are also included. Unit topics include Colored Solutions, Plants and Animals, Atoms and Molecules, and Earth Science - Rocks. (CS)

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ELEMENTARY SCIENCE GUIDE

4TH GRADE

1978

SUPERINTENDENT OF SCHOOLS
ANCHORAGE SCHOOL DISTRICT
4600 DEBARR ROAD
ANCHORAGE, ALASKA 99504

SE 031 448

JUL 15 1980

FOREWORD

This Resource Book has been prepared for use with instructional kits distributed through the Anchorage School District Science Center. These kits were developed by the Elementary Science Curriculum Committee under funding by ESEA Title IV B & C in response to student and teacher identified needs.

The individual units at each grade level are based on curriculum which has been developed by the National Science Foundation in the 1960's. The curriculum has been taught by thousands of teachers throughout the United States. The Anchorage School District adopted this curriculum and our Anchorage teachers have adapted it to fit our needs and our scope and sequence. The Anchorage School District is enthusiastic about this effort and believe that this guide and the Science Center will represent more effective and efficient ways of teaching science.

The process of curriculum planning and development requires the help of many teachers, principals and administrators. We appreciate the cooperation and assistance of everyone who has contributed to this project.

E.E. (GENE) DAVIS, ED.D
ASSISTANT DEPUTY SUPERINTENDENT

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The guide material was written by the following people:

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TABLE OF CONTENTS

If you are using this
guide for the first
time turn to page vii .

Foreword . . . .

Acknowledgements . . . .

Table of Contents . . . .

Outcome Statement . . . .

(To be taught in any sequence)

Colored Solutions

Plants and Animals

Atoms and Molecules

Earth Science: Rocks

6

OUTCOME STATEMENT

For Students Grades K-6 -- Science

The major outcome of science education in the Anchorage Schools is the development of scientifically literate citizens. A scientifically literate person is generally described as a person who:

- Understands enough of the fundamental concepts of the physical and biological nature of the world so that he/she may act responsibly.
- Possesses science skills and processes that give rise to facts and concepts.
- Possesses attitudes or values generally associated with science such as curiosity and respect for data.
- Uses science concepts, skills and values in making decisions as he/she interacts with other people and with his/her environment.
- Is aware of the interrelationship taht exists between cultural, philosophical, environmental, and social changes and scientific and technological advancements.

The role of the elementary school is to provide concrete, first hand experiences for students so that they may begin the process of becoming scientifically literate citizens. Because a child's mind changes in the manner it operates, and does not simply increase in capacity as it matures, the K-6 outcomes will be concrete and demand direct student observations. Nevertheless, these outcomes are important prerequisites for the later outcomes.

By the end of the sixth grade a student should be able to:

- Observe and describe a simple event using more than one sense.
- Record and share observations with others.
- Classify a set of objects.
- Collect and organize simple data.
- Interpret the meaning of simple data
- Set up a simple experiment to answer a question
- Read scientific materials critically.

OUTCOME STATEMENT (Continued)

- Demonstrate a basic understanding of the function of the ecosystem and his/her relationship to it.
- Demonstrate a basic knowledge of the systems of the human body.
- Demonstrate a basic knowledge of physical science concepts to which he/she has been introduced.

1 Each unit will have:
A. A listing of kit and non-kit items.
B. Supplemental materials list.
C. Teacher background information.
D. A schedule.

UNITS
Listings
Information
Schedule

August — July
S M T W T F S

2 The units have been developed to be taught anytime throughout the year.

3 The approximate times needed for each unit are included to help you in your long range planning.

Long Range Plans

Work Sheet
MASTERS

4 Worksheet masters are included in your guide for reproducing.

5 Call the Science Center if you have a problem.

TEACHER'S RESOURCE BOOK

FOR

COLORED SOLUTIONS

GRADE 4

September 1978

Superintendent of Schools
Anchorage School District
4600 DeBarr Road, Anchorage, Alaska 99504
Telephone (907) 333-9561, Extension 231

A Program Development Division Production

COLORED SOLUTIONS

Grade 4

KIT

Colored Solutions T.M.
Data Sheets - Consumable
18 plastic trays with covers
108 Vials
72 Droppers
18 Plastic molds with 3 depressions
20 cardboard trays
4 Containers concentrated food coloring,
    (blue, red, green, yellow)
8 Squeeze bottles and caps
36 Plastic spoons
50 Souffle cups
8 half-gallon containers and covers
10 lbs. salt*
100 straws - clear plastic or 1 box
2 sticks of modelling clay
4 cups sugar
1 multi-purpose balance
1 quart rubbing alcohol
7 100 ml. plastic beakers
1 measuring cup
3 plastic pails
1 roll of labels
1 quart white vinegar

* Let us know if that's enough or too much

NON-KIT

Buckets for waste water
Hot water
Crayons
Non-toxic liquids
Liquids from home

COLORED SOLUTIONS

GRADE 4

INTRODUCTION:

This unit is based entirely on the Elementary Science Study unit "Colored Solutions". There are references throughout this resource guide to pages in the teacher's manual.

The lessons in this unit have been written so that your students will be able to carry out experiments with simple equipment - droppers of food coloring and vials of liquids of various densities - and draw conclusions based on their observations of the experiments.

It is based on the idea that children will achieve more when they become involved in the experiment. They will be able to see for themselves that certain results occur when simple experiments are performed.

At times, throughout the unit, you will want the students to proceed individually and at their own speed. At other times you will want the whole class to work on the same activity.

The lessons are designed to allow your students to follow many side paths for experimentation. For example, the first lessons allow for much exploration with the behavior of food coloring in water. Another exploratory lesson involves the behavior of salt in water with food coloring. Your schedule and the students' interest should be the only limit to this kind of creative work.

You will probably find it best to divide your class into working groups of two students. This arrangement will enable the students to work and converse easily as they discover new things. This arrangement will allow you to become a "Classroom Manager" rather than a source of all information. You will be free to move from group to group, encouraging the students to answer their own questions by experimentation.

Teachers who have used a discovery approach to teaching have found it important to have four points well in mind before beginning each lesson. These points are to have:

1. Lead-off Questions
2. Follow-Up Questions
3. Activities
4. Discussion Questions

If you can proceed with these ideas you should find the unit of work exciting for both you and your students.

Student pictures, data tables, reports, talks are all part of student involvement for this unit. It is important to blend together the activities of each lesson with these reporting techniques.

Evaluation objectives in this unit are labeled B., I., and A.

(B) Basic - a lower level of achievement. Almost everyone should be able to achieve at this level.

(I) Intermediate - a higher level of achievement. The majority of students in the class should be able to achieve at this level.

(A) Advanced - evaluations at still a higher level. Students achieving at this level will have out performed the majority of their classmates.

SCHEDULE:

The unit is broken into 7 lessons. There are accompanying data sheets for the students in each lesson which are consumable and could be made into a booklet for the students to take home at the conclusion of their work. They should be retained throughout the unit to serve as reference material for subsequent activities.

This unit consisting of nine sessions has been designed to take from 6-10 hours depending upon the maturity of the students. It should be run over a five week period of time. The time period could be broken into 45 minutes to 1 hour periods two or three times each week. Using the 45 minute pattern will allow enough time for your students to explore their ideas, with 15 minutes for clean up.

EVALUATION:

It is difficult to design evaluative devices for the experimental science described in this unit. If you allow your students the freedom to explore you will never be sure what has happened until it does. If you do feel that evaluation is needed, two possible directions can be followed:

a. Observation - This is perhaps the most natural form of evaluation. If you use observation techniques for the unit of work, it will be necessary for you to move from group to group, asking questions and listening to your students. Watch each student closely as he or she applies what they have learned to new situations.

b. Evaluation suggestions in the teacher's manual, page 44. Some of these offer more formal written evaluation ideas, especially suggestions (2) and (4). Unit objectives from the E.S.S. Evaluation Program have been reprinted with each lesson and can further serve as a basis for observational and written evaluation.

ADVANCE PREPARATIONS AND MATERIAL MANAGEMENT:

Starting with Lesson 4, you will need to prepare salt solution of a specific concentration prior to lesson time.

To facilitate hand out and clean up of materials, you may wish to issue each team of students a set of materials consisting of 1 plastic tray plus lid, 1 palette with 3 depressions, 4 vials and 4 droppers. Students should mark their own kit. You may wish to appoint students to pass out and check in cleaned-up kits and as sink clean up. If your classroom does not have water, you will need to provide buckets of water to distribute and also a large container where students may pour the waste water.

LESSON I DROPPING, MIXING, WATCHING

Concepts: To observe and describe behavior of drops of food coloring in water.

E.S.S. Evaluation Program

UNIT OBJECTIVE 1: The student will describe the behavior of drops of food coloring in water.

Evaluation Objective	Goal Area
B. The student will describe the behavior of a drop of food coloring in water before it is stirred and after it is stirred.	Rational Thinking Process (Observation), Concepts
B. The student will describe the result of mixing drops of different colors in the same tube of water.	Rational Thinking Process (Observation)

Materials:	KIT	NON-KIT
	See Teacher's Manual, page 10.	

Advance Preparation: Review lesson on pages 10-15, Teacher's Manual.

Pass out to each pair of students 1 plastic tray and cover, 4 plastic vials, 4 droppers, 1 plastic mold with 3 hollow depressions. Have the students label the kits. Put "slop buckets" here and there for students to dispose of waste water. Set up dispensing stations where students may obtain refills on colors or you may wish to appoint students to pass out the colors.

To dilute the colors (3 small containers of each color) mix 2 parts of water with 1 part of food coloring and stir.

Ideas that work:

a. Record on chart for unit: 2 to 3 station leaders to set up and clean up refill stations ahead of time. Spread newspapers on empty desks or tables.

b. Students sit in pairs. Experiment on one desk (kit on newspaper). Write on other desk to avoid wet data sheets.

c. The use of notebooks, folders and individual data sheets is recommended.

d. Teacher: Demonstrate use of droppers, i.e., one drop at a time into solution, how to carry solutions in kit tray to dump when full, and how to wipe tray with towel for clean up. (Complete washing at sink not necessary!)

e. Names may or may not be taped to kits. Record team captains responsible for checking in kits with correct number of droppers, etc. returned to appropriate places.

Procedure:

1. Introduce the equipment and its use. Explain your desired clean up and management procedures. Dispense colors.

(Lead-Off Question)

2. Ask, "What do you think will happen if you add a drop of food coloring to water?"

3. After students have voiced their ideas, let them experiment to find out. Allow this initial exploration to extend for quite a while before you introduce the data sheets.

4. Introduce the data sheets as a means of recording their observations and facilitating their communications. Allow students to work through the data sheet.

5. When most of the students have concluded their work and have recorded their observations, take the time to let the children discuss their findings.

COLORED SOLUTIONS

DATA SHEET #1

Dropping Mixing, Watching

NAME ______________________

You will need a plastic tray, 4 vials, 2 plastic droppers, 1 plastic mold which you will fill with some of each color.

1. What happens when you drop food coloring into a vial of tap water?

____

____

2. Why do you think the color appears lighter in the dropper than in the vial?

____

____

3. How many seconds does it take for the color to spread out if you don't stir it?

____

4. What do you have to do to make a doughnut or smoke ring drops in the water? How can you avoid making smoke rings?

____

____

5. Does the height from which a drop falls make a difference? Tell why?

____

____

6. Can you make the color stay in the middle of the tube? Tell why or why not.

____

____

LESSON II LOOK AGAIN

Concept: To observe in greater detail the interaction of food coloring and water and to explore some of the variables that affect this interaction.

Materials:

KIT	NON-KIT
Student's kits	Hot water
6 squeeze bottles of coloring	Buckets
Data Sheets	

E.S.S. Evaluation Program

UNIT OBJECTIVE 2: The student will identify variables affecting the outcome of an experiment in colored solutions.

Evaluation Objective	Goal Area
B. Given a problem related to the mixing rate of food coloring in liquids, the student will identify two variables that might be involved.	Rational Thinking Process (Variable Identification)

Advance Preparation: Review pages 10-15, Teacher's Manual, prepare diluted colored solutions.

Make sure the squeeze bottles have enough colored solutions in them. Heat water to about 100° on a hot plate or use hot tap water if you should be so lucky.

Procedure:

1. Go over clean up procedure if you wish. Have students pass out kits to pairs of children.

(Lead-Off Question)

2. Ask, "Do you think the order in which colors are added to the vial affects the resulting color you get?"
3. Allow students some time to explore color mixing, then distribute data sheet.

(Follow-up Question)

4. After students have had time to work on color mixing questions and recorded their data, ask, "Can you make any color stay down in the tube?

Procedure:

5. Allow children more exploration time and the opportunity to think about reasons why the food coloring may go down in water before you call for a discussion of observations.
6. Give the students a chance to discuss their findings after most have finished.

COLORED SOLUTIONS

DATA SHEET #2

Look Again

NAME ______________________

1. Add colors to water in this order - 1 drop red, then 1 drop blue. Now try 1 drop blue then 1 drop red in a fresh vial of water. Do you get the same color? ________ What color? __________

2. Try 1 drop green, then 1 drop red in a fresh vial of water. Now try 1 drop red and then 1 drop green in a fresh vial of water. Do you get the same color? ______ What Color? __________

3. Can you make black? _______ If so, what colors did you use? _______

   ____

4. Using a fresh vial of water, can you make any color stay down in the vial? Try some different ways.

   ____

5. Try dropping color into cold water. Now try dropping it into hot water. Can you see a difference? __________ If so, what:

   In cold water ______________________________

   In hot water ______________________________

6. Why do you think the food coloring goes down in the water?

   Think of as many ways as you can.

   a. ____

   b. ____

   c. ____

   d. ____

19

LESSON III SALT, WATER AND FOOD COLORING

Concept: To observe, evaluate and communicate behavior of salt in water and food coloring.

Materials:

KIT	NON-KIT
Plastic containers of equipment which were issued day 1. Diluted food coloring (red, blue, and green) 1 small plastic spoon per student 1 souffle cup of salt per pair	None

E.S.S. Evaluation Program

UNIT OBJECTIVE 5: The student will describe similarities and differences among the properties of substances used for colored solution investigations.

	Evaluation Objective	Goal Area
B.	The student will identify the similarities and differences between the behavior of food coloring in salt water and plain water.	Rational Thinking Process (Observation)
I.	Given statements of the behavior of food coloring in plain and salt water, the student will infer the differences in the properties of plain and salt water.	Rational Thinking Process (Inferences and Prediction)

Teacher Background: Students may notice the "Schlieren" or "waves" that occur when salt is dissolved in water. Students who have observed salt or brackish water and fresh water interacting in tide changes or in estuaries may have noticed the same phenomenon.

They may also notice that salt will dissolve in water up to a point (saturation) and that no further salt will enter into a solution unless the temperature of the water is raised. Solutions and dissolving time dependant upon temperature are further explored in the atoms and molecules units at both grades 5 and 6.

Salt water is denser, that is weighs more, then fresh water of an equal volume. Students will probably notice its tendancy to settle to the bottom under fresh water.

Advance Preparation: Review pages 16-18, Teacher's Manual. Prepare 30 souffle cups with 2 teaspoons of salt in each, prepare diluted food coloring.

LESSON III SALT, WATER AND FOOD COLORING (continued)

Procedure:

1. Pass out materials.

(Lead-Off Question)

2. Ask, "What do you think will happen when you add salt to water?"

3. Allow students some exploratory time and introduce Data Sheet #3 which outlines a number of experiments the students may do.

(Follow-Up Question)

4. When the students have worked with just salt and water for a while, bring out the food coloring and ask, "Do you think the food coloring will behave differently in salt water than fresh water?"

5. Students may record findings under #4 on data sheet. Those who finish early and have done a thorough job of observing and recording may wish to undertake the experiment outlined in #5.

6. When most students have had a chance to observe and record experiments with salt and water, and salt, water and food coloring, let the children have some time to share their findings.

COLORED SOLUTIONS

DATA SHEET #3

Salt, Water and Food Coloring

NAME ______________________

You and your partner will need your tray of materials, 2 spoons, a souffle cup of salt, and later, food coloring.

1. Place some salt in a vial. Then carefully add, drop by drop, plain water. What do you observe?

____

____

____

2. Place fresh water in a vial. Add salt a little bit at a time. What do you observe?

____

____

____

3. Fill a vial with tap water and add salt water to it, drop by drop. Tell at least 2 things you discovered about salt and water mixing together.

   1) ____

   2) ____

4. Experiment by dropping colors into vials full of salt water. Tell at least three things you discovered about salt, water, and color mixing together.

   1) ____

   2) ____

   3) ____

5. There is another experiment to try. You can find out if a liquid spreads down faster than it spreads up. Place several droppers full of colored salt solution under water in 1 vial. In another vial place clear salt solution. Carefully add colored plain water on the top. What happens?

____

____

LESSON IV COLORED SOLUTIONS

E.S.S. Evaluation Program:

Unit Objectives 3, 7, 8 and 11.

UNIT OBJECTIVE 3: Upon completing a scientific investigation, the student will communicate his procedures and findings to others.

Evaluation Objective	Goal Area
B. The student will describe orally what was done and what happened in a scientific investigation.	Communication
I. The student will write a short report of his procedures and conclusions in a scientific investigation.	Communication
A. The student will prepare a report including a description of the procedure, a graphic display of data collected, and a statement of conclusions.	Communication

UNIT OBJECTIVE 7: When conducting scientific investigations in colored solutions, the student will record observations in a systematic manner.

Evaluation Objective	Goal Area
B. The student will record in writing or in pictures his observations about the behavior of food coloring in liquids of different densities.	Rational Thinking Process (Data Organization), Communication
I. The student will develop and use a system of symbols to describe the behavior of food coloring in liquids of different densities.	Rational Thinking Process (Data Organization), Communication

UNIT OBJECTIVE 8: The student will make inferences about the density of liquids from given observations or data.

Evaluation Objective	Goal Area
I. Given observations on the mixing behavior of food coloring in certain liquids, the student will arrange the liquids in order of density.	Rational Thinking Process (Classification)

LESSON IV **COLORED SOLUTIONS** (continued)

UNIT OBJECTIVE 8: (continued)

B.	Given observations about the layering behavior of two colored solutions, the student will conclude which of the liquids is the heavier.	Rational thinking Process (Inference and Prediction)

UNIT OBJECTIVE 11: The student will classify objects and describe the basis for classification.

	Evaluation Objective	Goal Area
I.	Given liquids of different densities, the student will group the liquids from heaviest to lightest.	Rational Thinking Process (Classification)
I.	Given a relative density scale and both liquid and solid substances, the student will classify the substances according to their position on the scale.	Rational Thinking Process (Classification)

Concepts: To investigate what happens when drops of liquid of one density is placed in a liquid of a different density.

To determine how many combinations are possible if four liquids are to be tested.

To infer differences in composition of the liquids.

Materials:

KIT	NON-KIT
Plastic trays of materials 4 cups salt (Solutions mixed in advance) 4 half-gallon plastic containers	Red, blue, green crayons

Advance Preparations: Review pages 20-25 in Teacher's Manual.

Use the quantities given on page 20 of the Colored Solutions Teacher's Manual to prepare salt solutions ahead of time.

NOTE: THIS LESSON WILL PROBABLY TAKE TWO FULL CLASS PERIODS.

Procedure: Follow page 21 of the Teacher's Manual.

1. To color the solutions with the class.

2. Divide the class in half. Let one half of the class work with green and clear solutions, and the other half of class with red and blue solutions.

(Lead-Off Question)

3. Ask, "What happens when drops of one liquid are placed in another liquid?"

4. Give the children data sheet #4 as a place to record up-down data.

5. When the children have had a chance to observe and experiment with the liquids and record their findings, let them switch colors and experiment again. You may find this a convenient stopping place for day 1.

(Follow-Up Question)

6. When all the children have again had a chance to observe and experiment with the liquids and record their findings, ask, "What other 2-color combinations can you think of?"

7. Record their suggestions on the board. Then give them time to follow through and try these new combinations. By the end of this activity the children should have a very good idea of which liquid always seems to go down, which liquid seems to go up, and which are in the middle. To graphically demonstrate the up-down relationships you could have the students color vertical rectangles representing a 2-color pair.

For Example:

Procedure:

8. Allow discussion time for the question, "Why do you think the colored solutions act differently?" As children mention "heaviness", you may introduce the term "density" as a measure of mass per volume. Children can relate to their experiences of something that is heavy or light for its size.

Optional Activity:

Put up a chart with the different combinations of liquids:

B	B	B	C	C	C	R	R	R	G	G	G
G	R	C	B	R	G	B	G	C	B	C	R

Letters could be made using crayons or magic markers of corresponding colors (example: B writen with blue).

Children are given vials of each color prepared solutions and experiment seeing which color goes to the top and which to the bottom. Results are compiled and put on master chart as follows: If student found that when he mixed Blue with Green, blue came to the top and green to the bottom he would put a check under B/G on the chart. If however he found that green came to the top and blue to the bottom he puts a check under G/B. After all or most of students record data on master chart, go over chart and discuss any items of disagreement.

COLORED SOLUTIONS

DATA SHEET #4

Colored Solutions

NAME ______________________________

You will need your kit of materials. You will also need solutions from containers marked G, R, C, and B; however, you will be working with only two at a time.

1. Put clear into green.
   What color goes up? ______________________________

   What color goes down? ______________________________

2. Put green into clear.
   What color goes up? ______________________________

   What color goes down? ______________________________

3. Put red into blue.
   What color goes up? ______________________________

   What color goes down? ______________________________

4. Put blue into red.
   What color goes up? ______________________________

   What color goes down? ______________________________

5. Using all the vials, how many different 2-color combinations can you try? ______ What are they? ______________________________

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

DATA SHEET #4 (continued)

6. Try as many as you can think of - Record your results here so we can compare results.

7. Why do you think the colored solutions act differently?

LESSON V LIQUID LAYERS IN SODA STRAWS

E.S.S. Evaluation Program

Unit Objectives 8, 9, 10, 11.

UNIT OBJECTIVE 8: The student will make inferences about the density of liquids from given observations or data.

	Evaluation Objective	Goal Area
I.	Given observations on the mixing behavior of food coloring in certain liquids, the student will arrange the liquids in order of density.	Rational Thinking Process (Classification)
B.	Given observations about the layering behavior of two colored solutions, the student will conclude which of the liquids is the heavier.	Rational Thinking Process (Inference and Prediction)

UNIT OBJECTIVE 9: Given the scientific terms used in the colored solutions unit, the student will demonstrate knowledge of the terms.

	Evaluation Objective	Goal Area
B.	The student will define the term density.	Concepts.
I.	Given an activity involving liquids of different densities, the student will select a term (e.g., heaviness or downness) to describe the behavior of the liquid.	Concepts, Communication

UNIT OBJECTIVE 10: The student will demonstrate the proper technique for using simple scientific apparatus.

	Evaluation Objective	Goal Area
B.	The student will demonstrate the proper technique for using a pipette or similar apparatus (e.g., a soda straw or plastic tubing).	Manipulation
I.	The student will demonstrate the proper use of the balance scale.	Manipulation
I.	The student will demonstrate the proper use of a measuring cup or a graduated cylinder.	Manipulation

UNIT OBJECTIVE 11: The student will classify objects and describe the basis for classification.

Evaluation Objective	Goal Area
I. Given liquids of different densities, the student will group the liquids from heaviest to lightest.	Rational Thinking Process (Classification)
I. Given a relative density scale and both liquid and solid substances, the student will classify the substances according to their position on the scale.	Rational Thinking Process (Classification)

Concepts: To summarize and utilize the learnings from Lesson 4.

To use simple tests to determine where 2 liquids belong on the up-down scale.

NOTE: THIS LESSON WILL MOST LIKELY TAKE 2 DAYS.

Materials:

KIT	NON-KIT
4 previous solutions	Crayons
"purple" and "yellow" solutions	
36 clear straws	
36 extra vials	
36 extra balls of clay	
Data sheets	

Advance Preparation: Review pages 26-30 in Teacher's Manual. Make a new batch of solutions again using the same formula given on page 20. Use the identical color scheme. Discard any left over solutions from the previous lesson rather than combining.

In addition, you will need for your most advanced students on the first day, and for the remainder of the class on the second day, the "unknown" solutions described on Teacher's Manual, page 32. Make a duplicate amount of the clear solution at the same time that you make the refill, as directed on page 32. Also make the second unknown, "purple" by following the directions on the bottom of page 32.

Procedure:

1. Demonstrate the technique for making straw "sandwiches" by following the steps outlined on the bottom of Teacher's Manual, pages 26-27.

LESSON V LIQUID LAYERS IN SODA STRAWS (continued)

(Lead-Off Question)

2. Ask, "Can you make a red on blue sandwich?" Introduce data sheet 5. Read through part 1 with the students and encourage them to try to make a R/B sandwich.

(Follow-Up Question)

3. After the students have achieved success with the above sandwich, ask, "Can you predict which of the "sandwiches" given under part 2 of your data sheet can be made?"

Procedure:

4. When most of the students have completed the predictions, encourage them to try them to see if they can be made or not. Have the students keep track under part 3 of the data sheet.

5. Encourage the students to share their findings as to which 2-layered sanwiches can be made. If there is disagreement, let the children resolve their own differences of opinion.

6. After the students have had experience with making 2-layered sandwiches, ask them to first predict then attempt 3 and then 4-layered sandwiches. The four-layered sandwich can only be done one way, with the densest solution on the bottom and the least dense on the top. Students can make the 4-layered sandwich "permanent" by sticking the bottom of the straw in a ball of clay and then removing a finger from the top of the straw.

This may be a convenient stopping place for the first day. Not all of your students will get this far, others may be able to go on to the "unknowns".

7. Introduce the 2 "unknowns", yellow and purple. Explain that yellow is the same as one of the 4 known solutions. Challenge the students to think of and attempt experiments to determine which solution yellow is. Explain the term density to mean "occupies the same place on the "up-down" scale. Students will enlarge their concept of density in the final lesson, in which the relationship of weight per volume is determined.

(Follow-Up Question)

8. Ask, "What reasons can you give why you think yellow is the same as ____________?"

Procedure:

9. Encourage the students to determine what "purple" is using similar techniques to the ones utilized in investigating "yellow", and to locate it on their data sheets in the up-down scale. From densest to lightest, they should have: green, red, purple, clear and blue.

10. Write on the chalkboard "For the next class we need: small cans of fruit juice, small amounts of liquids, etc. Ask parent or guardian first."

COLORED SOLUTIONS

DATA SHEET #5

Liquid Layers in Soda Straws

NAME ______________________

You and your partner will need = Your kit of materials
2 extra vials
2 transparent soda straws
2 clay balls 1" in diameter

1. To make a two-layered blue on red sandwich, dip the straw about half-way into the blue liquid. The top of the straw is open. Place your finger firmly over the top of the straw, and remove the straw from the liquid. The blue liquid will remain in the straw. Keeping your finger on top, lower the straw about one inch into the red solution. Release your finger. A half-inch layer of red solution will move into the straw, pushing the blue layer up to the level of the solution in the vial.

   Again put your finger over the top of the straw, and remove the straw from the red solution. You will have a blue on red sandwich.

2. Before you try making any more sandwiches, use what you have already learned about the solutions to mark the following predictions. Which of the two-layered liquids below can be made so that the layers stay and do not mix? The letter on the top will be the color on top. The letter on the bottom will be the color on the bottom.

   Make your predictions by drawing a circle around those you think can be made. Draw an X across those you think can not be made.

$$\frac{B}{G} \quad \frac{B}{R} \quad \frac{B}{C} \quad \frac{C}{B} \quad \frac{C}{R} \quad \frac{C}{G} \quad \frac{R}{B} \quad \frac{R}{C} \quad \frac{R}{G} \quad \frac{G}{B} \quad \frac{G}{C} \quad \frac{G}{R}$$

3. Now try them and when you are finished, compare results with the class. Keep track of the ones you can do below.

4. Try to make three and four-layered sandwiches. Before attempting this, use a crayon and draw the layers you think you can make. If you succeed in making a 4-layered sandwich, stick the bottom of the straw into a ball of clay. This will hold the straw for you.

   Keep a record to compare with other members of the class.

1. ____ 2. ____ 3. ____ 4. ____ 5. ____

____ ____ ____ ____ ____

____ ____ ____ ____ ____

Which is the most "up" liquid? ______________
What's the most "down" one? ________________

LESSON VI ENLARGING THE UPNESS-DOWNNESS CHART

E.S.S Evaluation Program

Objectives 8, 10 11.

Concepts:	To extend the up-down chart to take in new substances. To classify new substances according to density.	
Materials:	KIT	NON-KIT
	Sugar Measuring cup All previous solutions 36 clear straws 36 extra vials Data sheets	Many liquids brought from home.

Advance Preparation: Review pages 34-37, Teacher's Manual. Encourage students to bring in some nontoxic liquids to test. Prepare sugar water by mixing 2 CUPS SUGAR WITH 1 QUART WATER to make a more "down" (denser) liquid than green. Limit the number of liquids being tested by agreement so that there will be some continuity in the discussion. You may, however, wish to let some students expand the number of items tested after they have completed the ones the class has agreed upon.

(Lead-Off Question)

1. Introduce the new liquid(s) and ask, "how can you find out where it belongs on the up-down scale?" (or "What its density is in relation to others?")

Procedure:

2. Determine if the children understand that the unknown liquid may go above blue or below green, between any of the 4 known liquids, or in the same place as any of the known four.
3. Warn the children not to taste any of the liquids or any liquid they're not sure of.
4. Hold a discussion with the children of their placement of liquids on the scale and their reasons for so doing.
5. Allow advanced students to pursue investigations on Teacher's Manual, pages 42-43.

COLORED SOLUTIONS

DATA SHEET #6

Enlarging the Upness-Downness Chart

NAME ________________________

You and your partner will need your kit of materials plus four extra vials and a sample of liquids that you wish to test.

1. List the liquids you will test. _______________, _______________

   _______________, _______________, _______________, _______________

   _______________, _______________, _______________, _______________

2. Are any liquids below (Denser than) the bottom color on your scale? Which liquids?

   ___________________________________ were denser than the bottom color.

3. Are any liquids above (less dense than) the top color on your scale? Which liquids?

   _______________________________ were less dense than the top color.

4. Place your liquids on the following scale ________ less dense

   ____

   ____

   ____

   ____

   ____

   ________ More dense

5. Share your findings with the class.

DATA SHEET #6

(continued)

6. Copy class conclusions here:

________ Less dense

____

____

____

____

____

____

________ More dense

7. List 2 things you learned from this experiment.

1) ____

____

2) ____

____

8. Working with two unknown solutions. You will need a sample of "yellow" and a sample of "purple". Work with "yellow" first. It was prepared the same way as one of the other four solutions, and has the same density. Find out which one it is. What tests can you use to determine this? One way might be to determine its "up" or "downness". What are some others? Keep a record of your experiments and what you decided it was.

Yellow is the same as ________________________________

because ____.

DATA SHEET #6

(continued)

When you are finished with yellow, try "purple". Can you locate purple on the "up-down" scale?

_______ Up = less dense

____

____

____

_______ Down = denser

Purple has a density greater than (goes below) ____________________

and less than (goes above) ____.

LESSON VII WEIGHING THE LIQUIDS

E.S.S. Evaluation Program

Unit Objectives 12 and 13.

UNIT OBJECTIVE 12: The student will determine the relative weight or volume of an object or substance.

Evaluation Objective	Goal Area
B. Given a beaker of sugar water, of salt water, and a plain water, the student will use a balance scale to determine their weights.	Manipulation, Rational Thinking Process (Measurement)

UNIT OBJECTIVE 13: When exploring the behavior of colored solutions, the student will willingly contribute and participate in classroom activities.

Evaluation Objective	Goal Area
B. The student will state observations about the behavior of colored solutions.	Rational Thinking Process (Observation), Attitudes
I. The student will develop questions that will lead to further study of colored solutions.	Rational Thinking Process (Making Hypotheses), Attitudes

Concepts:

To determine the relative weights of equal volume of the various liquids.

To determine a relationship between the established "up-down" scale and results obtained by weighing.

To use weight to identify an unknow liquid.

To develop the concept of density to mean weight (or mass) per volume.

Materials:

KIT	NON-KIT
Multipurpose balance 4 liquids, sugar water, and alcohol 7 100 ml. plastic beakers Droppers from student's kits Measuring cup Salt - 4 cups Sugar - 2 cups Data sheets	None

LESSON VII WEIGHING THE LIQUIDS (continued)

Advance Preparations: Review pages 38-41, Teacher's Manual. Mix up a fresh batch of the four basic solutions and color as usual. Mix up one quart of sugar water as before by adding 2 cups of sugar. Also have on hand 8 oz. rubbing alcohol. Assemble the multipurpose balance with pans. Keep it out of sight.

1. Procedure - Show the children the six liquids. Ask a volunteer to arrange them in order according to up-down scale (density).

(Lead-Off Question)

2. Ask, "Why do you think this kind of order can exist? What is it about the different liquids that makes it possible for us to arrange them in an up-down order?"

Procedure:

3. Write suggested explanations on the board. Hopefully the children will suggest "weight" as a possible explanation.

(Follow-Up Question)

4. Ask, "What do you mean by weight or heaviness?"

5. Ask, "How can we list the weight or heaviness of a liquid fairly?"

   After hearing explanations, choose a *small* container of a *dense* liquid (green sugar water) to compare with a *large* container of a less dense liquid (blue). Say: You mean this green sugar water weighs more than this blue water?" Children will respond to use *equal amounts* of each.

6. Introduce the multipurpose balance and the seven 100 ml. plastic beakers.

7. If the children suggest it, weigh the beakers to see if they're equal.

8. Pour a liquid in each of 6 beakers up to 90 ml. mark. Select some students to *carefully* bring the levels of the liquids up to 100 ml. by using droppers. Have the students place the liquids near the balance.

9. Ask one student to place what he/she thinks is the "lightest" (least dense) liquid in the left pan. Ask a 2nd student to place what he/she thinks is the "next heaviest" in the right pan while you keep the arms from tipping.

10. Ask the class to predict which way the arm will swing when you release the arms. Try it!

11. Continue with the other colors until all the liquids have been tested. Is there a relationship to the up-down scale?

12. Reintroduce the term density to take in heaviness per volume. (Data Sheet #7 question #1). The heavier liquid is more dense than an equal amount of a lighter liquid.

13. Optional Activities:

A.	Up-Down Game	Teacher's Manual, page 41
B.	Mystery Liquid	Teacher's Manual, page 41

14. Use Data Sheet #8 as an optional evaluation. It can be done individually, or with a partner. Items can be changed for different groups. Use as a center activity using the equal arm balance.

COLORED SOLUTIONS

DATA SHEET #7

Weighing the Liquids

NAME ____________________________

You will be watching a teacher demonstration.

1. The new factor used to order the liquids using equal amounts of different liquids which are lighter or heavier is called ___________.

2. Arrange the liquids in order according to the new factor.

    1. ________________________ less dense
    2. ________________________
    3. ________________________
    4. ________________________
    5. ________________________
    6. ________________________ more dense

DATA SHEET #8

MINI QUIZ!

NAME ______________________________

List 6 items brought in by class, preferably different from Data Sheet #7.

1. ____________________ 4. ____________________

2. ____________________ 5. ____________________

3. ____________________ 6. ____________________

Arrange the liquids in order according to relative density. Check your results by using the equal arm balance.

____

____

____

____

____

______________________________ more dense

Relative density means ____

____

____

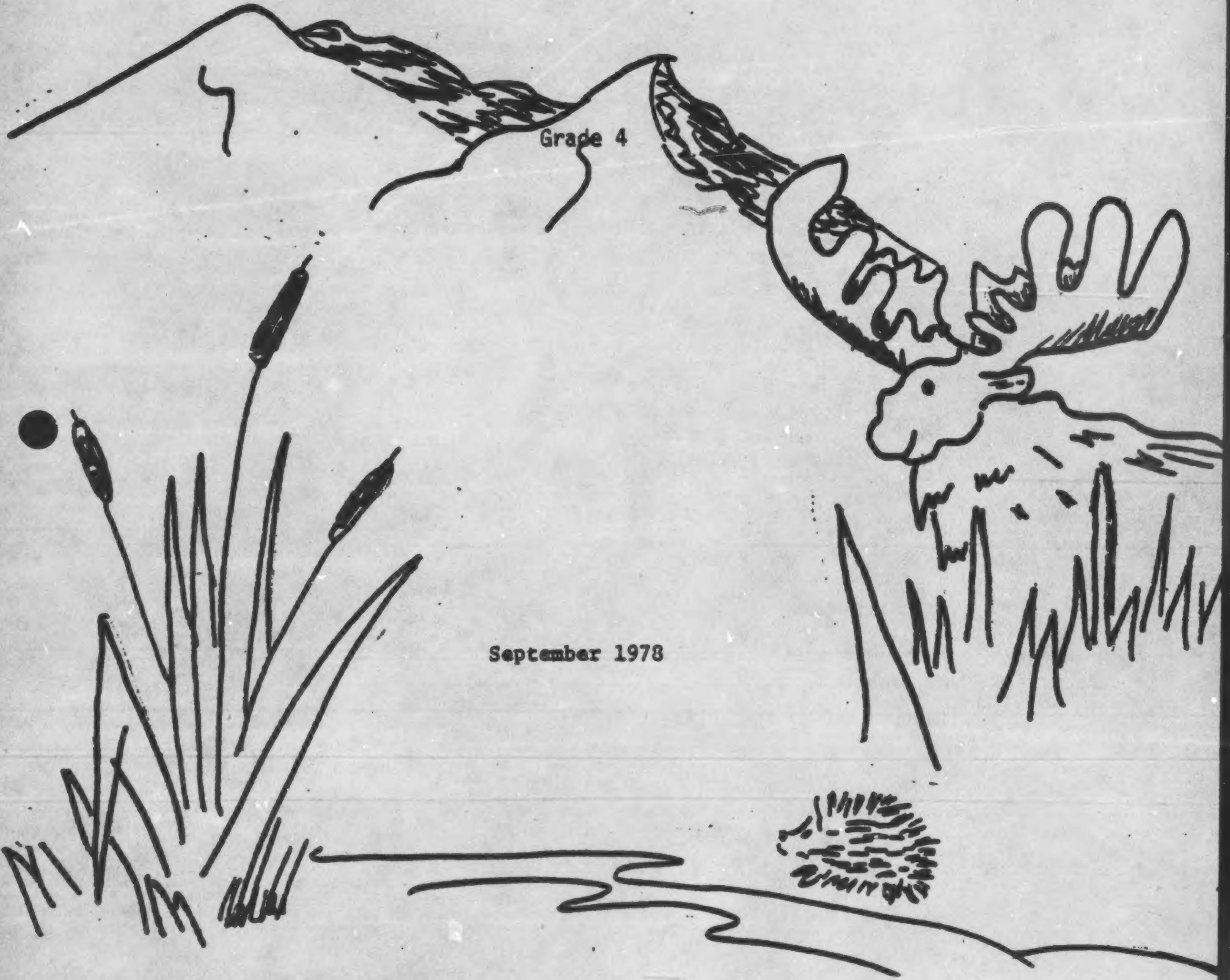
____

Give an example using 2 of the above liquids.

TEACHER'S RESOURCE BOOK

FOR

PLANTS AND ANIMALS



Grade 4

September 1978

Superintendent of Schools
Anchorage School District
4600 DeBarr Road, Anchorage, Alaska 99504
Telephone (907) 333-9561, Extension 231

A Program Development Division Production

PLANTS AND ANIMALS

Grade 4

MATERIALS FOR A CLASS OF 32:

KIT

1 bones T.M.
1 booklet "How to Build a Chicken Skeleton"
1 booklet "Picture Book of Bones"
1 picture packet of bones
A keyed collection of mystery bones
1 set X-ray filmloops of bones
6 animal skeletons including at least 1 cat, 1 mink, and 1 rabbit
6 velour sheets
40 envelopes
1 bag potting soil
1 package corn seeds
1 package red raddish seeds
1 package white raddish seeds
1 package lima bean seeds
1 package mung bean seeds
1 package sunflower seeds
2 packages albino corn seeds
1 package wheat seeds
1 package grass seed
18 felt tip markers
20 Petri dishes
17 3 oz. plastic cups

NON-KIT

Butcher paper
Knee joint of calf or lamb
Milk cartons
Paper toweling
Various plants
17 metric rulers

SUPPLEMENTARY MATERIALS:

The material shown below can be used to supplement this unit of work.

FILMS:

F-1644	MECHANICS OF LIFE
F-104	THE DINOSAUR AGE (1958)
	HEMO, THE MAGNIFICENT
	WONDER OF OUR BODY
	YOUR BODY AND ITS PARTS
F-2439	DINOSAURS
F-741	HUMAN BODY = SKELETON (1953)
F-513	SEED GERMINATION
F-676	WONDERS OF PLANT GROWTH (1953)
F-773	PLANT LIFE AT WORK (1955)
F-1209	WHAT PLANTS NEED FOR GROWTH (1958)
F-1448	WHAT DO FLOWERS DO?
F-3218	STRENGTH OF PLANTS

BOOKS:

BUILT TO SURVIVE - White
A IS FOR ANATOMY - Cosgrove
WONDERS OF YOUR BODY

UNIT

UN-281	HUMAN SKELETON

PLANTS AND ANIMALS

Grade 4

INTRODUCTION:

Observing, classifying, predicting, inferring, are four of a number of processes we all need to be skilled in using. This unit of work, along with several other science kit units, is designed to strengthen the child's skill at using these processes. The mode of the unit attempts to take advantage of the child's natural curiosity by presenting materials via discovery or inquiry techniques, hence blends conceptual patterns with process.

Your involvement is with the children, in your classroom, and not of handling materials any more than is absolutely necessary. The more you can promote student involvement with - setting up - running - taking down the experiments, the greater the learning. Some children may be reluctant to participate at first but with patience they will. As you read through the unit you may decide that a different sequencing of units would be better for your children. Feel free to make what changes you feel will enhance the learning package. If your children become excited with certain sections of the unit, let them explore!

The unit is divided into two basic parts—bone and measuring growth in plants. Don't be afraid to do the bones section. Check with the other teachers to see what they have done. If you won't be repeating what they may have already done, move full speed ahead. Start the plants part first, then go to bones, then come back to plants after they have grown enough to continue with the activities.

BONES:

Your children will be given the opportunity to discover the group (classify) a variety of bones. They will be examining genuine skeletons and will become familiar with the similarities between certain bones of different animals. The children will actually assemble the bones of a rabbit, cat, mink, or wild Alaskan mammal.

For you not-so-sure people, be assured that your children can and will meet the challenge of assembling the bone puzzle. The majority will succeed in grasping a sense of familiarity with some of the basic bones in the body and the action of each.

Super 8 Film-Loops:

The single concept film loops included in the kit can be used at any time during the check-out time. Generally these filmloops have been used after the initial work with the actual bones. The film loops show several X-ray movies of different parts of the body moving. The filmloops are very useful in showing that the bones do not "bend" when the body parts move, but the bones move in "joints" that are held together by tough string-like material called "ligaments".

Bone Overlays and Bone Models:

A packet of overlays are included in the kit materials. You will find these helpful in introducing certain concepts in the unit. The comparative nature of bones of different animals is a natural part of the unit.

MEASURING PLANT GROWTH:

Plants require a few days to germinate. For this reason you may want to introduce this phase of the unit after a day or two of work with the bones. Also you might want to review with your students the conditions necessary for seed germination.

Problems:

Three basic considerations need to be carefully watched as your children work with the growing phases—too much water; too little water; not enough sunlight. If your students over-water, the seeds will mold. If this becomes a problem, puncture the bottoms of the containers to allow for some drainage. Holidays and weekends pose just the opposite problem--lack of moisture. If this becomes a problem, place a plastic bag around the plant. This will make a small greenhouse to prevent rapid moisture loss.

If the seedlings do not appear within approximately one week, you might want to remove some soil from one of the containers and examine the seeds. It may be that the seeds were planted too deep. If this is the case, water the soil and wait.

If you feel that all conditions are suitable, but the seeds have not germinated, it is possible that the seeds are dead. To find out, simply take some seeds from the package, put them into a small container and cover with water. After soaking for a day, select those seeds that seem slightly enlarged and plant.

Three reference booklets, a large bone chart and single concept film loops have been included in the science kit. These materials are the original source from which this unit was written. Take a few minutes to read the teachers' manual for other ideas. The booklet "How to Make a Chicken Skeleton" can be used as an exciting optional lesson either to run concurrently with the three-week unit or as a culminating activity.

The questions you ask should lead to more questions by the children. Each question leads to a new experiment. Questions such as the following are excellent stimulators.

> "Which bones fit together?"
> "Are the leg bones longer than the other bones?"
> "Where are the flat bones in your body?"
> "Which bones could be used for a curve of the back?"
> Etc.

Assembling the Backbone and Ribs:

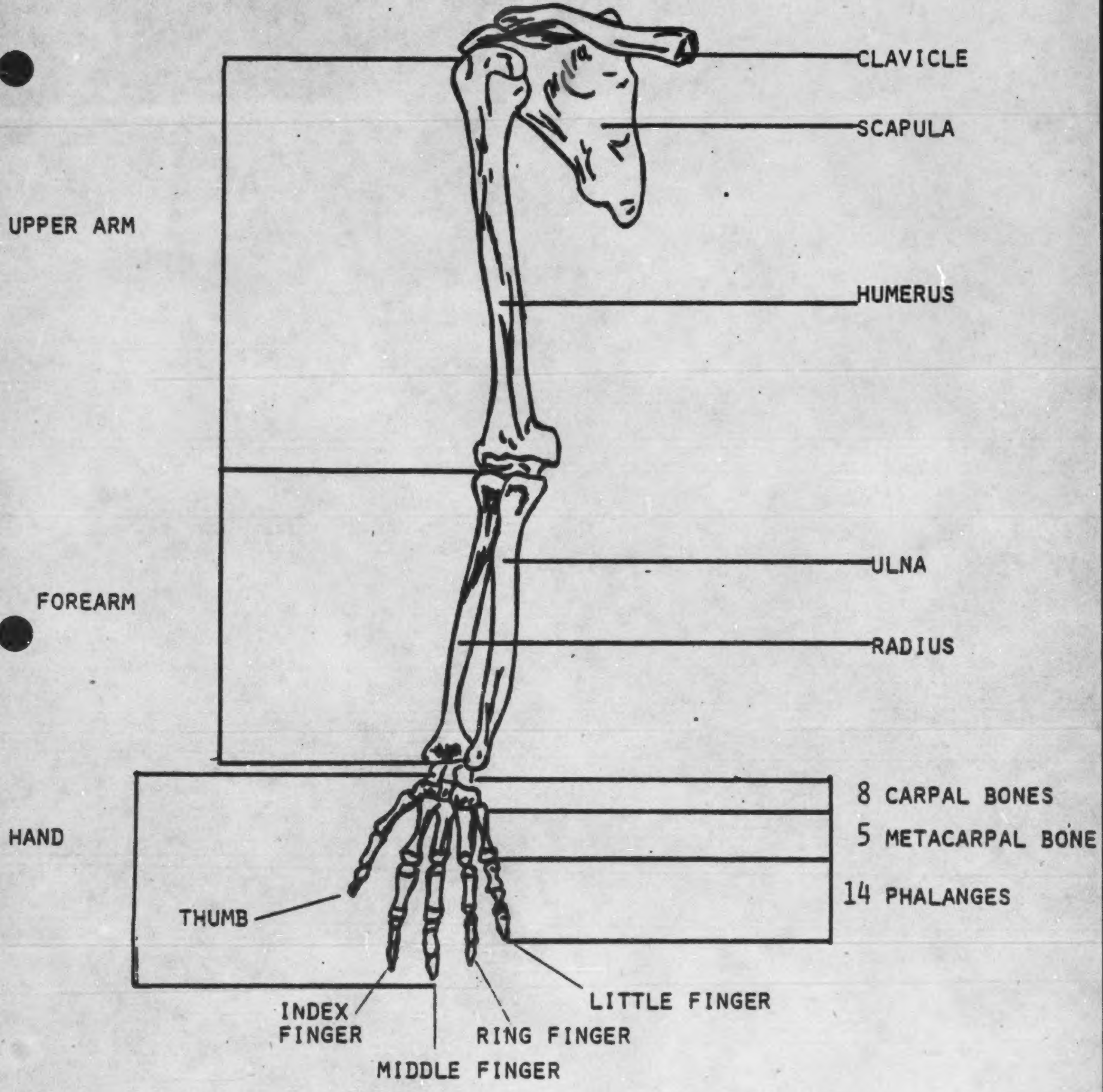
These two areas are often difficult for the children at first. You might help by asking questions like, "Is the backbone or ribs just one bone?" "Are they made up of several bones hooked together?" You might have the students sort the vertebrae into groups that look alike and then assemble the bones in each group. It doesn't matter if some bones are not in the correct order. A difficult vertebrae to identify is the atlas bone. To identify this bone, tell the children to "search for the bone that makes a good connection with the knobs on the back of the skull."

You can anticipate questions about the vertebrae. "What are the holes for?" They should be aware that the large central hole of each vertebrae lines up to make a continuous "tube". Solicit their ideas about the functions of this tube. Neck vertebrae can be recognized by the two smaller holes for arteries leading to the head. Assembling the ribs is sometimes tricky for students. If they have trouble, have them recognize that the ribs are paired, and no ribs are attached to neck vertebrae. They can determine rib arrangement by feeling their own ribs and backbone.

Velour Sheets:

The blue velour sheets included in the kit will allow for groups of 4-6 students to work together. Since there are no sides on the velour sheets, caution your children about keeping the bones on the sheet. If you want to store the velour sheets, with the bones on them, from one period to the next, be sure to have two children carry the velour sheet. This will prevent spilling the bones -CAN YOU DISTINGUISH CAT BONES FROM RABBIT BONES FROM MINK BONES?

BONES OF ARM AND HAND


CLAVICLE
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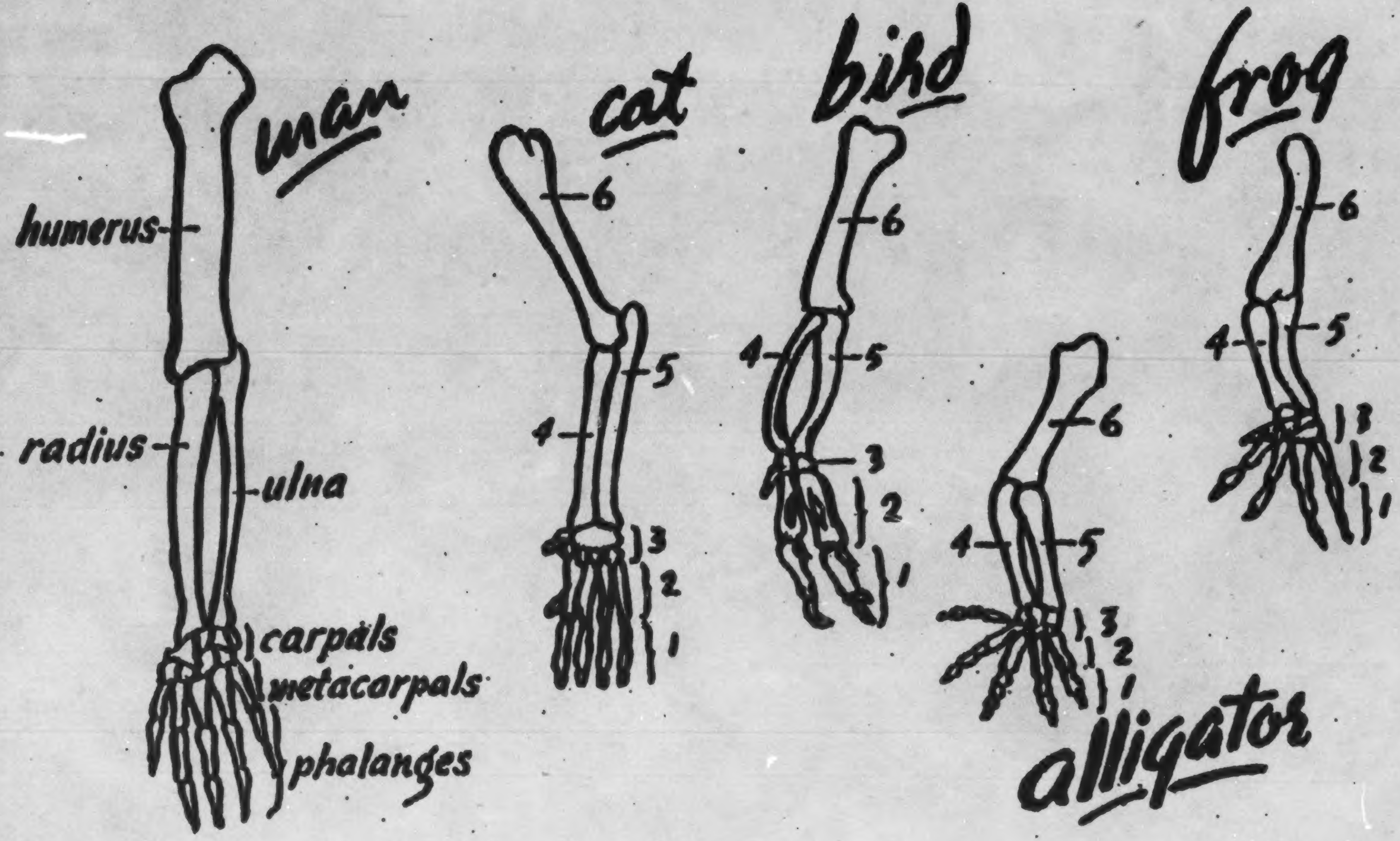
HUMERUS
ULNA
FOREARM
RADIUS
8 CARPAL BONES
HAND
5 METACARPAL BONE
14 PHALANGES
THUMB
INDEX FINGER
LITTLE FINGER
RING FINGER
MIDDLE FINGER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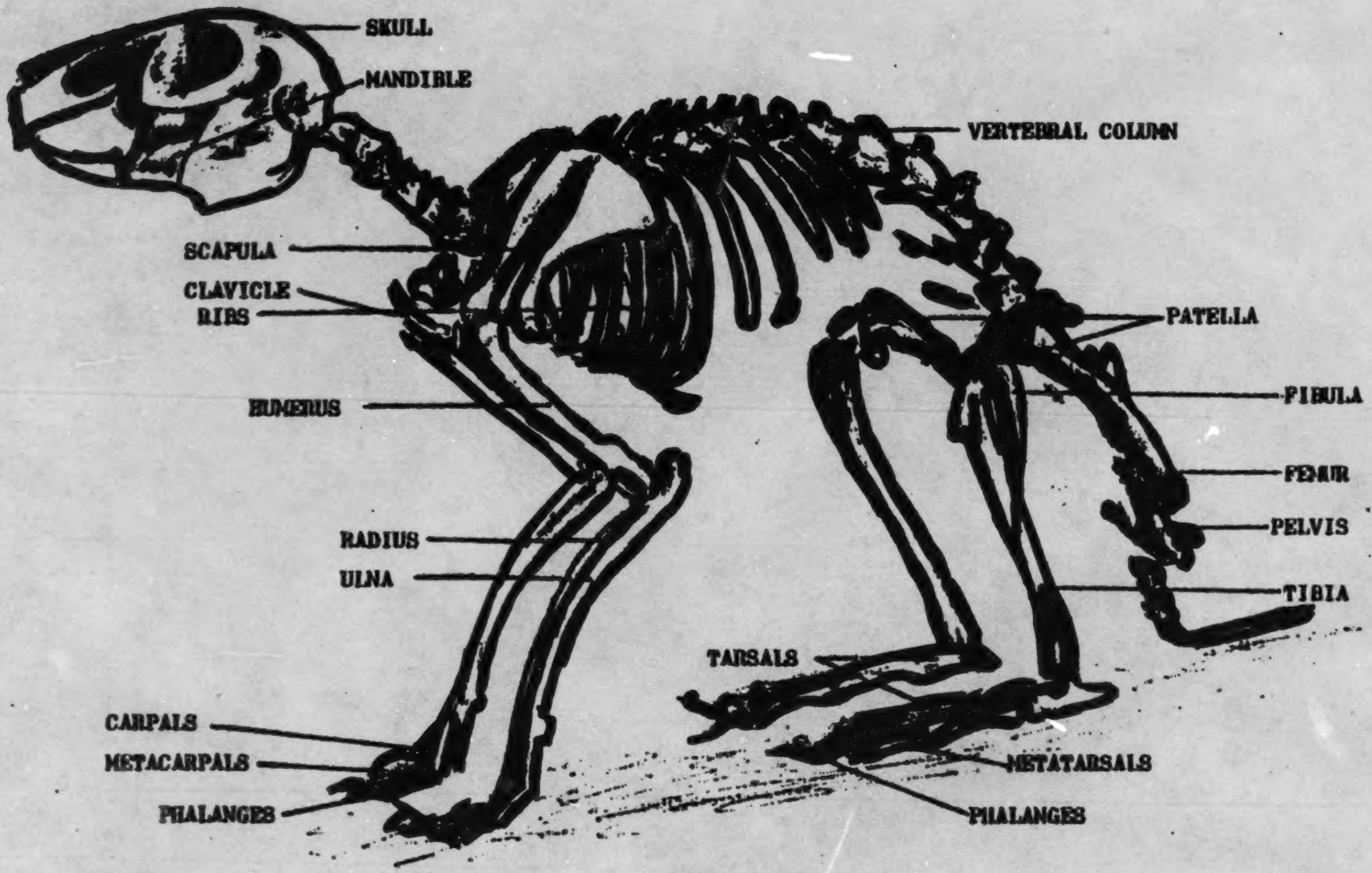
SKULL
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TIBIA
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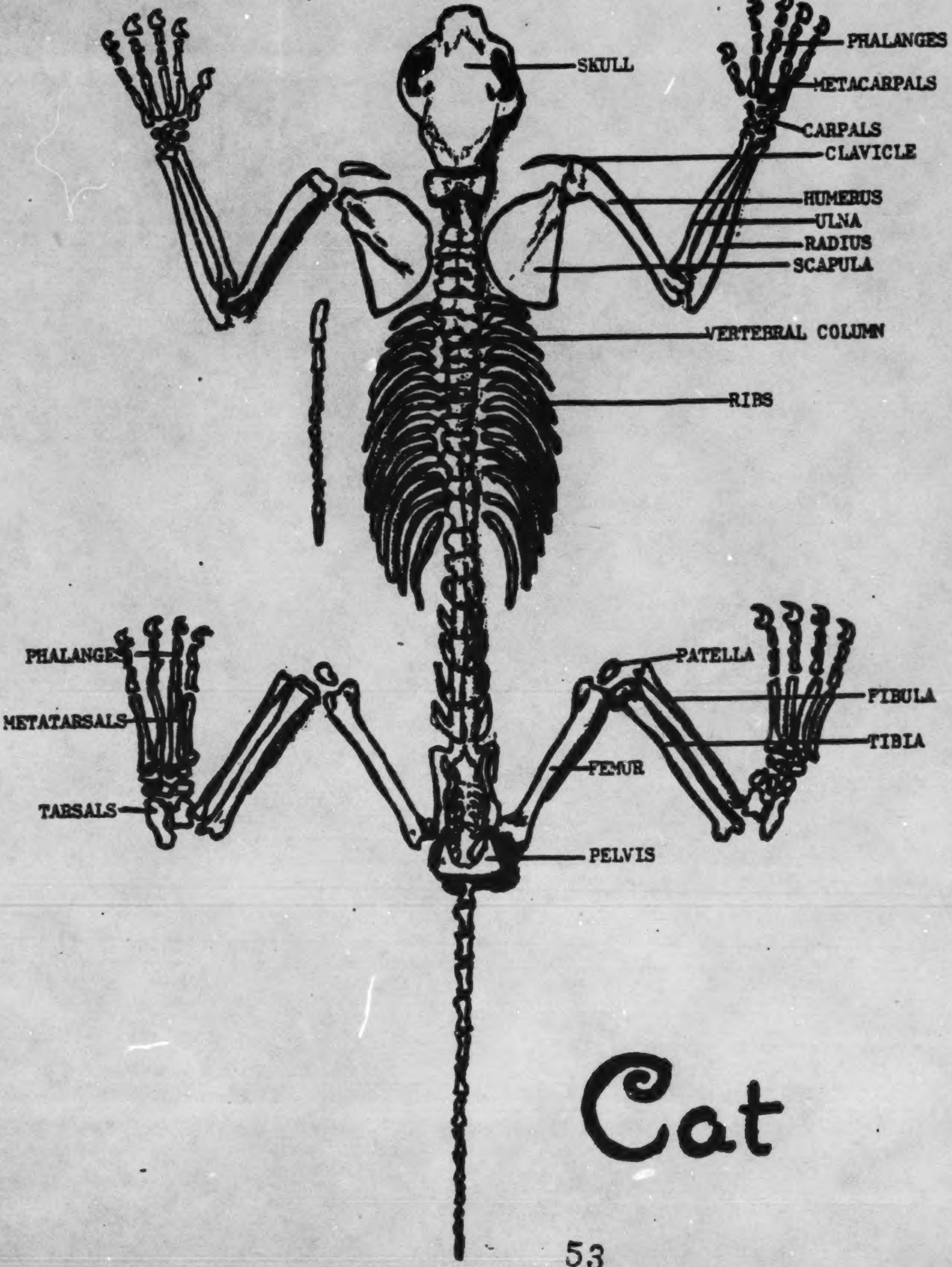
METATARSALS
PHALANGES
PHALANGES

Rabbit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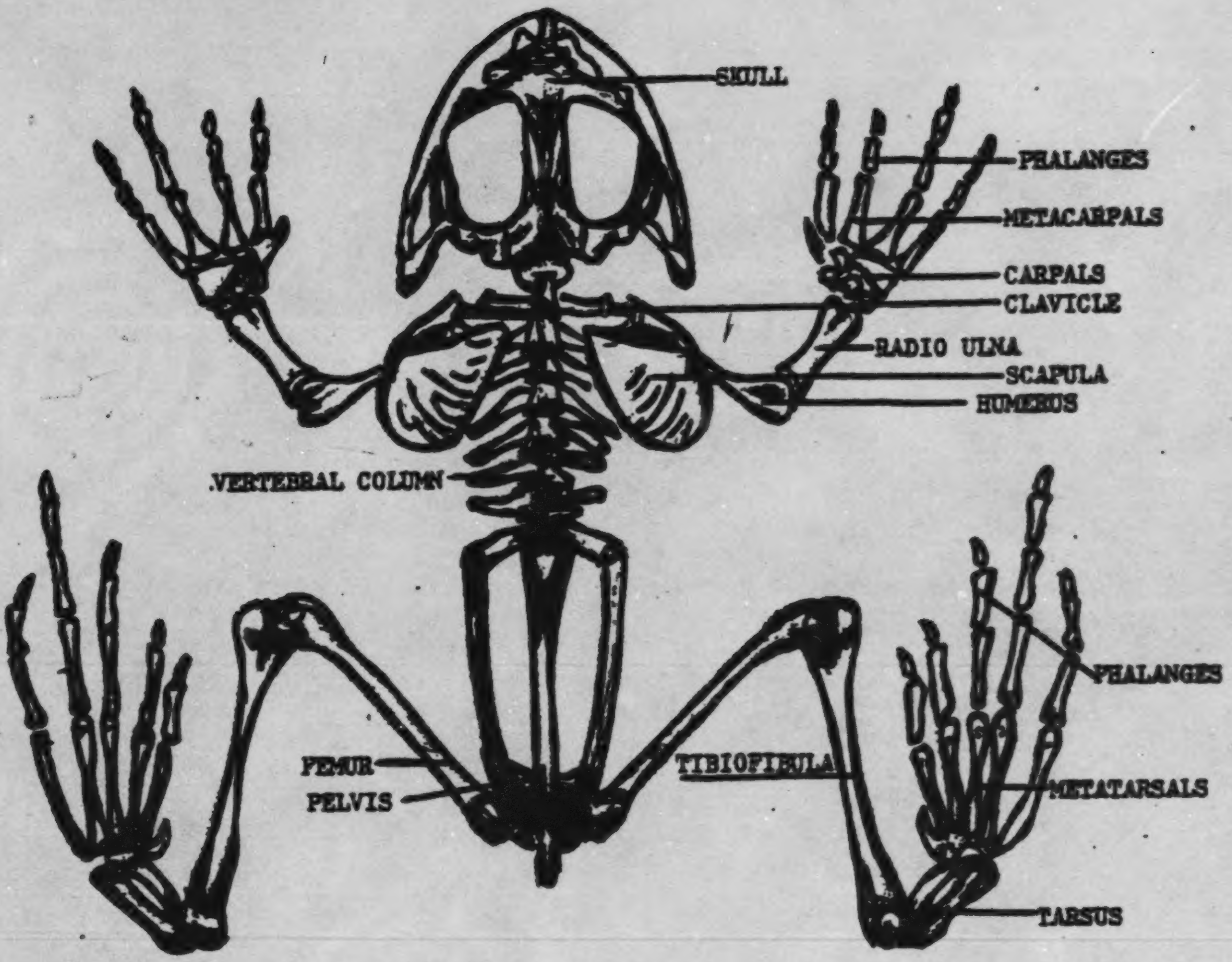
PATELLA
FIBULA
METATARSALS
TIBIA
FEMUR
TARSALS
PELVIS

Cat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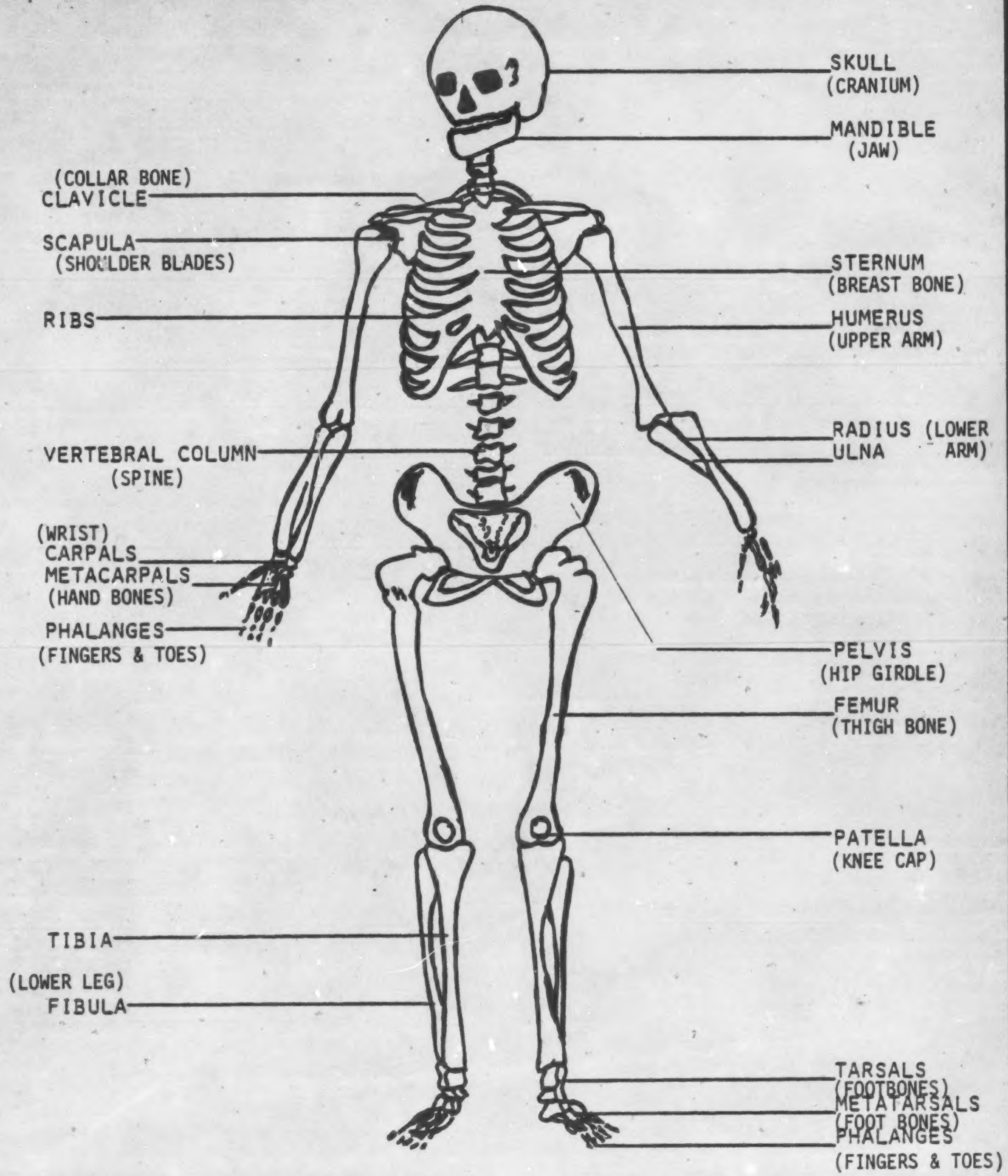
SCAPULA
HUMERUS
VERTEBRAL COLUMN
PHALANGES
FEMUR
PELVIS
TIBIOFIBULA
METATARSALS
TARSUS

Frog

Comparison of Bone Names

SCIENTIFIC NAME	COMMON NAME	BUTCHER'S NAME
SKULL	HEAD BONE	
MANDIBLE	JAW	
CLAVICLE	COLLAR BONE	
SCAPULA	SHOULDER BLADE	BLADE
STERNUM	BREAST BONE	
RIB	RIB	RIB
HUMERUS	UPPER ARM BONE	SHOULDER
VERTEBRAL COLUMN	BACKBONE	CHUCK BONE (part of backbone)
RADIUS AND ULNA	LOWER ARM BONES	SHANK BONE
CARPALS	WRIST BONES	
METACARPALS	HAND BONES	
PHALANGES	FINGER BONES	
PELVIS	HIP BONE	AITCH and HIP BONES
FEMUR	THIGH BONE	THIGH BONE
PATELLA	KNEE CAP	
TIBIA	SHIN BONE	SHIN BONE
FIBULA		
TARSALS	ANKLE BONES	
METATARSALS	FOOT BONES	
PHALANGES	TOE BONES	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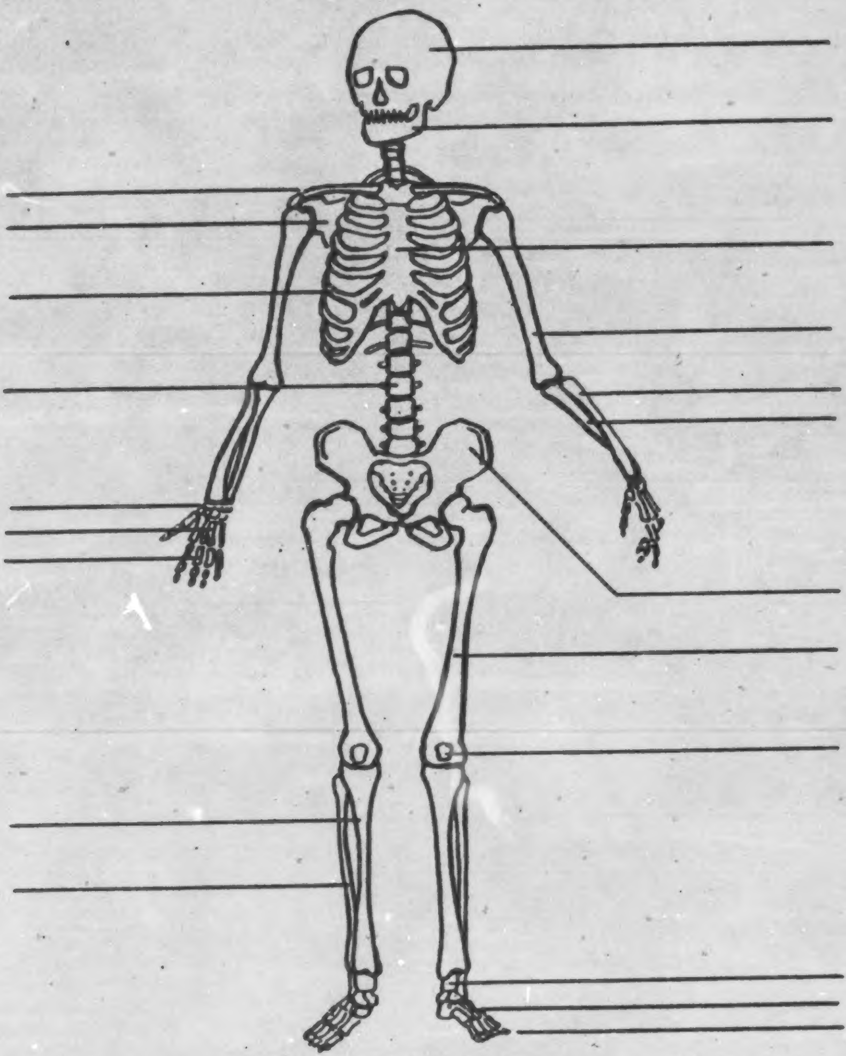
(CRANIUM)
MANDIBLE
(JAW)
(COLLAR BONE)
CLAVICLE
SCAPULA
(SHOULDER BLADES)
STERNUM
(BREAST BONE)
RIBS
HUMERUS
(UPPER ARM)
RADIUS (LOWER
ULNA ARM)
VERTEBRAL COLUMN
(SPINE)
(WRIST)
CARPALS
METACARPALS
(HAND BONES)
PHALANGES
(FINGERS & TOES)
PELVIS
(HIP GIRDLE)
FEMUR
(THIGH BONE)
PATELLA
(KNEE CAP)
TIBIA
(LOWER LEG)
FIBULA
TARSALS
(FOOTBONES)
METATARSALS
(FOOT BONES)
PHALANGES
(FINGERS & TOES)

HUMAN

Names of Human Bones



LESSON I GROWING PLANTS FROM SEEDS

Concepts: To order the germination rates of various seeds. To order growth rates of different parts of root, stem and/or leaf of a plant.

* This lesson is one of several aimed at involving the children in the life cycle of plants. Many factors effect the germination of seeds and the growth of stem, roots and leaves of the plant. Most children will be quite surprised to observe that all parts of the plant do not grow at equal rates. You might want to start the unit by asking the children to make inference as to what will happen to the seed. These statements can then be placed on the board and later the students will see which inferences were correct, and which were not.

Materials:

KIT	NON-KIT
Potting soil - 1 bag	Milk cartons
Envelopes - 40	
Corn Seeds - 1 package	
Red radish seeds - 1 package	
White radish seeds - 1 package	
Lima bean seeds - 1 package	
Mung bean seeds - 1 package	
Sunflower seeds - 1 package	
Albino corn - 1 package	
Wheat seed - 1 package	

Procedure:

1. Prepare enough small envelopes so there is one envelope for each pair of students.

2. Pass out a variety of the seeds provided in the kit. Each pair should have 3-10 seeds of one kind.

(Lead-off Question)

3. Ask, "What are the seeds like?"
   "Are they all alike?"
   "What will happen if the seeds are planted?"
   "Are they all the same?"
   "Will they all grow the same kind of plant?"

4. Each student pair should plant at least one container. Enough milk cartons can be provided so each student can plant his own.

5. Before the children plant the seeds, review the proper way to plant seeds. This should be a student discussion. Do not tell them what to do! You might start the discussion by asking, "When you plant seeds, what should you do first?"

6. Possible answers could include the following:

   a. Soak the seeds first to make them soft.
   b. Fill the container with dirt.
   c. Put the soil just barely over the seed.
   d. Label the containers so we know what is in them.
   e. Add water daily - but don't over-water.

   Have the children follow the predetermined planting procedures.

(Follow-up Question)

7. Ask, "How soon will the plants come up?"
   "What will the plants look like?"
   "How fast will the plant grow?"
   "How big will the plant grow?"
   "How can we find out answers to these questions?"

8. Make plans for record-keeping. One possible record table is shown here.

Name of Seed	What the Seed Looks Like	Date Planted	Date Plant Emerged	Height in Centimeters Second Day After Emergence	Height in Centimeters Third Day After Emergence	Etc.

9. After a few days, discuss the following:

   a. Not all the plants will appear at the same time. Some may never come up.
   b. Some plants grew faster than others.
   c. Different plants had different colors, e.g., albino corn and regular corn - red and white radishes.
   d. We cannot tell by looking at a seed exactly what it will produce.

LESSON II

Materials:	KIT	NON-KIT
	Picture packet of bones	Butcher paper

(Lead-off Question)

1. Ask, "What kinds of animals have bones?" Some animals may provoke a discussion--frogs, snakes, sharks, eels--which may be resolved with the help of reference books.

2. After students have listed a wide variety of animals, ask, "Can we draw a picture of a skeleton showing the bones many animals have in common?" Volunteers may draw skeletons on the board, or each student may draw a generalized skeleton. Do not spend too long on this part.

3. Obtain some butcher paper for teams of students. The butcher paper should be long enough to draw the student on. Have one student in each group lie down on the butcher paper. The other students, in the group, can then trace around his body with crayons. (This lesson might be better accomplished in the hall or cafeteria floor.)

4. When the outline is complete, ask, "Can you draw the bones of the body on the outline?"

5. Perhaps the students will want to name the major bones on their drawing. Do not require that students memorize the names of the bones! If they learn some of the names, as they work with their drawing - fine.

6. Allow your students time to consider their drawings and compare them with the pictures.

60

OPTIONAL GAMES TO FACILITATE LEARNING NAMES OF BONES

NOSE TO KNEE GAME:

Recommended for use outside or in the gym. Arrange the class into teams of twos. Arrange the class, then, into two circles, one smaller inside circle and a larger outside circle. One team member should be in the inside circle, one in the outside circle.

On your signal, the inside circle revolves in a clockwise direction while the outside circle remains in place. The outside circle members can stand, sit, or lay down...their choice.

Let the children circle several times while you select two scientific names for human bones. You would then call the two names out loud: "Clarical to Scapula," or "Fibula to Carpals."

Once you have announced the second bone part, the inside circle disperses as quickly as they can through the scramble to their partners. Once each inner circle person locates his parter, the partners place the two bone parts together....the first bone from the inside circle; the second from the partner in the outside circle. A simplified example will be: "knee to elbow" - the inside partner would run to his partner in the outside quickly placing and holding his knee on his partners elbow.

You can acknowledge teams for speed and use correct body parts.

SIMON SAYS GAME:

Lead-up to game: Student volunteer models as teacher points to bones on him/her. Starting with skull, both common names and scientific names are used to name bones.

Game: Begin by reviewing technical names. Simon says, "Touch your clavicle." Simon says, "Touch your cranillon," Simon says, "Touch your femur," etc.

Rules: This is played the same as Simon Says. Do only what "Simon" says to do! If leader just says, "Touch your mandible," etc., students should not respond to leader. Those who do are either out or can go to a designated part of the room and continue playing.

Follow-up: Hand out ditto of Human and have students print scientific and/or common names as a class activity. Some students enjoy memorizing these for an extra credit quiz.

LESSON III MYSTERY BONES

Concept: To classify bones according to shape, size, possible source or function.

Materials:

KIT	NON-KIT
Mystery bones	None

Procedure:

1. Place the different mystery bones on a table in front of the students. (Encourage your children to bring in mystery bones of their own.)

(Lead-off Question)

2. Ask, "Can you identify these bones?" Answers you would expect include ribs, legs, arms and perhaps a scientific bone name or two.

3. If the children cannot figure out the animal a certain bone came from, see if they can tell the approximate size of the animal. (The story on relative size could be read at this time - see "Other Student Activities".)

4. For a size reference, some teachers have suggested such things as mice, cats, cow, etc. Sometimes the students will do the reference patterns themselves, e.g., "Larger than a mouse but smaller than a cat."

5. It will be your decision whether to identify the mystery bones to your children or not. It is fun to have some mysteries which are never completely solved. Perhaps this can be one of them. Perhaps you have a place for displaying the mystery bones. If you do display them, you will find students continuing to solve the mystery.

6. Have your students sort bones into piles (classify) according to what kind of function they believe the bones have. You may have the children explain the reasons for sorting as they did and then trade with another group and sort again.

LESSON IV BONE JOINTS

Concept: To compare motion in human joints with other animal joints.
To observe human joints moving.

Materials:

KIT	NON-KIT
X-ray filmloops X-ray Picture Packet	Knee joint of calf or lamb

Procedure:

1. To introduce this lesson and to get your children interested about joints, you can leave the room and walk back in with as little movement as possible. Do this by keeping your entire body rigid and shifting slowly from leg to leg.

(Lead-off Question)

2. Ask, "Can you describe your appearance when you walk as I was walking?"

3. Have the students define the locations of their joints. Put these on the board as the students describe them. Some teachers have had their children demonstrate and then describe the joints.

4. At this time, show the students the EES filmloop X-rays of joint movements in humans. Post the six sketches from the X-ray Picture Packet in your room. The sketches illustrate all the joints shown on the filmloops and should be referred to when the X-ray films are discussed. The sketches are captioned by questions to direct the students' observations as they watch the loops.

5. If you can arrange to obtain a fresh joint of a calf or lamb from your local butcher, do so. Better yet, take your class to a local grocery and let the butcher describe the bones, the cartilage, etc., of the joint.

6. If you obtain the joint for your class, find a sharp knife and start cutting the joint away. Notice how the ligaments are spread out and interwoven over the entire surface of the joint. Under the ligament, they will see the layer of smooth cartilage covering the ends of the bone and, perhaps, around the joint, the membrane that secretes a fluid to lubricate it. Allow the students to touch the ball of the joint and see for themselves how slick and smooth it is. (A fieldtrip to the local grocery store might be appropriate here. The local butcher could do the original cutting for you.)

After the ligaments are dissected away and the bones are all exposed, work the joint back and forth to demonstrate its action.

Allow time for discussion.

"Is this the only type of joint in the body?"
"Where are the others and how do they work?"
"What other things have hinges?"

Your students will probably think of doors, crayon boxes, eyeglasses, books, "pop-it" beads, shower nozzles, etc.

"What would happen if the joints were not lubricated?"
"What does double jointed mean?"
"What do you think the ligament does?"
"What move a joint?"

63-A

LESSON V: ASSEMBLING BONES

Concept: To identify certain bones in different animals. Students will assemble a skeleton from a pile of bones.

* The animal bones are real!

Materials:

KIT	NON-KIT
Bones of 6 animals	None
Bone Picture Book	
Bone Charts	
Bone Overlays	
Single Concept Filmloops	
Velour Sheets	

Procedure:

1. During the assembling activities, do not allow your students to see a picture or model of the cat, rabbit or mink skeleton. The children will "figure it out for themselves".

2. One way teachers have found successful in introducing the unit is to use the bone picture book and large bone pictures. By asking appropriate questions the children will enter the games of identifying various animals and functions of certain bones. These pictures should be referred to at least two times during the unit work. Possible questions include:

   "How does this animal walk?"
   "Does this animal fly or swim?"
   "Does this animal eat meat or grass?"
   "Which is your teacher?"
   "How big do you think this animal really is?"
   Etc.

3. Once the pictures have been used, divide the class into groups of 4 or 5 children (this will depend on the number of children in your class - there are 6 velour sheets). Begin by giving each team a sheet and a box of bones. You probably won't have to even suggest to the children what to do with the bones. Stand back and see the involvement.

4. The students will put the animal skeleton together by laying them out. Do not let them use glue. This will take about two 20 minute periods. The bones and sheets can be stored with care. If suggestions become necessary, encourage the students to sort the bones into groups according to similarities in their structure.

5. Remember that the animal appears to be lying flat. This means the legs will be spread apart.

6. As you move from group to group ask:

"Which bones are quite different?"
"What do you know about cats and rabbits that can explain their differences?"
"How big is the rabbit foot compared to a mink or cat?"
"How does the cat walk?"
"How does the rabbit walk?"

The legs will provide the least assembly problems. The ball and socket joint of the femur and pelvis is easy to find and the hinge joint is equally as distinctive. The scapula may present difficulties, but this can be overcome by letting students feel for the shoulder blade of a live rabbit or cat. The pelvis may also be discovered this way.

The bones or the feet and hands invariably give students trouble. To cause awareness of the many bones of the hands and feet, have the children feel their own hands and then show them the X-ray picture of the hand.

The completed skeleton: Oftentimes the teacher will feel the finished project is more than adequate with many bones left over. It is not, however, essential for the skeletons to be assembled perfectly, and a perfectly assembled skeleton is by no means a ruler to measure the learning that has taken place. At this point you should show the students articulated models of their skeletons, or project the overlays of the three skeletons provided in the kit. Select the skeleton most accurately assembled, correct the mistakes that may have been made and allow the students to compare their work with the models and pictures.

LESSON VI COMPARING COMPLETED SKELETONS

Concept: To observe the comparative nature of different animals.

Materials:

KIT	NON-KIT
Assembled skeletons	None

Procedure: When the children have had a session or two assembling the skeletons of the mink, rabbit and cat, allow them to circulate and view the skeletons built by other groups. Ask them for their ideas about how these animal bones compare with their bones.

(Lead-off Question) Ask, "Does the cat have leg bones which are similar to yours?"
"Do the bones of your hand appear the same as the bones of the cat paw?"
"Are your leg bones bigger than your arm bones?"
"How about the cat, rabbit or mink?"
Etc.

OTHER STUDENT ACTIVITY

See booklet: How to Build a Chicken Skeleton

Now that you have had success with Lessons 1-5, refer to the EES teacher's manual for other activities which might interest your students. Some of the many possible directions include the following questions:

"Can you make a three dimensional chicken skeleton?"
"Can we find and make skeletons from other animals (dead bird, etc.)?"
"Are there other skeletons we can assemble?"
"How about starting a skull collection?"
"What if we cut a large bone and examine its inner structure?"
"Which animals have their bones on the outside?"
"What are the names of these bones?"
"How are bones used by Alaskan natives?"

The following story can be read to your class as a beginning discussion of the size of animals vs. the size of their home structure. The story of the characters in Lilliput is another you might consider.

"ON BEING THE RIGHT SIZE" by J.B.S. Haldane

* The original article has been modified for your grade level.

Could a hare be as large as a hippopotamus? Could a whale be as small as a guppy? For every type of animal there is a most convenient size. For every size, there is a convenient form.

Do you remember how big Gulliver was as he traveled through the land of the little people? And have you watched the television program called "The Land of the Giants?" Gulliver was more than 10 times as big as the people. This means he was more than 10 times as high, 10 times as wide and 10 times as thick - put together, this means that Gulliver weighed a thousand times what the little people weighed. How tall are you? How wide are you? How thick are you? Multiply each of these figures together and this is the weight of Gulliver! Unfortunately, unless Gulliver's bones increased their size, he would break his hip every time he took a step.

Let us take another example - suppose that a gazelle, a graceful little creature with long thin legs, is to become large. If this were to happen, it would break its bones unless it does one of two things. It may make its legs short and thick, like a rhinoceros. Or it can compress its body and stretch out its legs at an angle, like the giraffe.

Gravity would be a mere nuisance to the little people of Lilliput, but to Gulliver it would be a terror. To the mouse and any small animal, it presents practically no dangers. You could drop a mouse from a 1,000 foot building and, on arriving at the bottom, it gets a slight shock and walks away. (Probably to be run over by a car.) In the same situation, a rat would probably be killed, though it can fall safely from the eleventh story of a building - a man is killed - a horse splashes!

OTHER STUDENT ACTIVITY (continued)

An insect is not afraid of gravity at all. It can fall without danger, and can cling to the ceiling with little trouble. It can go in for elegant and fantastic forms to support its body weight. But don't get an insect wet! The problem has to do with a word called surface tension. Let's take an example of a man, a mouse and an insect to see what the term means. A man coming out of a bath carries with him a film of water about 1/50th of an inch thick, all over him. This weighs about a pound. A wet mouse has to carry about its own weight of water. A wet fly has to lift many times its own weight. Therefore, an insect going for a drink is in a great danger as a man leaning out over a cliff in search of food.

Tall animals have other difficulties. They have to pump their blood to great heights. Thus their veins and arteries have to be stronger than say for man. Large animals have other problems brought on by size. Curved intestines, large bones, lungs are just three systems which enable larger animals to overcome their problems of size. What it really amounts to is that the larger animals have to be more complex than the smaller animals.

For every type of animal there is an optimum size. Yet many people still think that if a flea were as large as a man it could jump a thousand feet into the air.

LESSON VIA **GROWING PLANTS IN LIGHT AND DARK** (Optional)

Concept: To distinguish plant growth with and without light.

Materials:

KIT	NON-KIT
17 3 oz. plastic cups	17 rulers
1 package grass seed	
Soil	

Background Information: Unit taken from Communities (SCIS) Chapter 3, pages 32-37.

Procedure:

1. Give student teams one 3 oz. plastic cup, 1 ruler, 1 label, grass seed, soil, and (water sprinklers).

(Lead-off Question)

2. Ask, "Do plants need light to begin growing?" "What can we do to find out?" Encourage discussion and solutions.

* Note: This lesson continues for a 2 week period.

3. Setting up experiment:

   a. Each team should fill its cup 3/4 full of soil, sprinkle a pinch (about fifty) of grass seeds on the surface. Cover with a thin layer of soil, and moisten the soil thoroughly with water sprinkler. Half of cups are "dark" and others "light." Label cups with names, the date, and "light" or "dark".

   b. Put "dark" cups in a closet or tightly sealed box. Put "light" cups under a light source or in direct sunlight. Check and water every two days for one or two weeks. (NOTE: Do not let "dark" cups in light for more than 1/2 hour.)

   c. "Why are the plants growing so well in the dark?" Discuss but do not tell the answer.

3. When students notice the plants in the dark are yellow and those in light are green, gather them for discussion. Ask, "Which plants do you think will survive best?" "Why?" "What might we do to turn yellow grass green?" "What might we do to turn green grass yellow?"

4. After discussion move 1/2 of the "dark" cups into the light and 1/2 of the "light" plants into the dark. Continue watering and look for changes in color and condition. (The yellow plants should turn green in a week. It will take longer for the green plants to turn yellow.)

(Follow-up Question)

5. Discuss the differences between plants in the light and plants in the dark. "What does light do for the plants?"

Tell students: Plants, like animals, need food to grow. Plants make food using light energy in a process called "photosynthesis." ("photo," "light," "synthesis," "putting together").

Ask, "Why did the grass grow in the dark at first?" (Starts growing using water, warmth, and cotyledons, but needs light to keep growing - example: grass under a board turn yellow, then dies.)

Children should be able to use their evidence to decide if plants make their own food.

Growth Chart:

Children should plot the growth of their plants on a chart like the following: (From Communities student workbook, page 4.)

LESSON VII GROWING PLANTS FROM SEEDS

NOTE: Do not start this lesson until plants are big enough to measure.

Concept: To order the growth rate of different parts of the plant - root, stem and leaf.

Materials:

KIT	NON-KIT
Felt-tip markers Plants	None

Procedure:

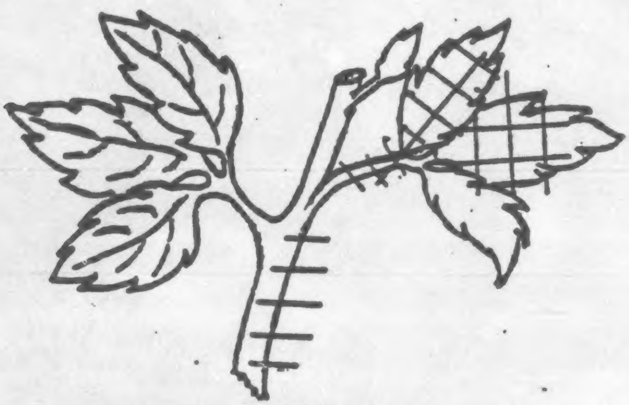
(Lead-off Question)

1. Ask, "How do we know that the plants are actually growing?" Answer could include a change in plant size and shape.

2. Ask, "Do all parts of a stem grow at the same rate?"
   "Does the leaf grow faster near the tip or near the base?"
   "How can we find the answers to these questions?"

3. Allow the children to try their own ideas, if possible! Do not discourage the child from trying his procedure even if you know it will not give the needed information. You can use the experiences later in discussing possible correct procedures. Have the children work in pairs.

4. One possible way to measure the stem and leaf growth is to mark off different lengths and make daily recordings of the increases. This will have to be done before plants are full grown. If the distance between marks does not vary, then that part of the plant is not growing. Marking can be done with a felt marking pen. The marks should be spaced evenly. A grid pattern on the leaves will allow measurement of growth in both directions.



5. "What conclusions can you draw about the growth of different parts of the plant?"
"Do some parts of the stem grow more rapidly than others?"
"Do leaves grow larger in all directions at the same time?"
"Do the different plants grow much the same way?"

LESSON VIII GROWING PLANTS FROM SEEDS (Optional)

Concept: To order the growth rate of a germinating seed and root.

* You will need to prepare corn seeds 3-4 days in advance of this lesson. Soak the seed for two hours and then put four seeds on each of three or four pieces of wet toweling inside a petri dish. You may want larger groupings for the lesson.

Materials:

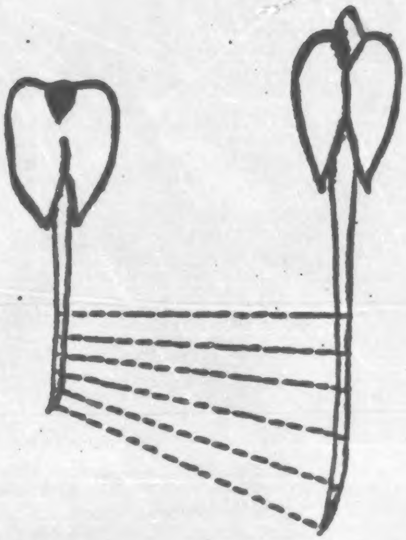
KIT	NON-KIT
Corn seeds - 1 package	Paper toweling
Petri dishes - 20	
Felt marking pen - 10	

Procedure:

1. Give the student teams a petri dish containing three or four germinating corn seeds on damp toweling. Also give the team a marking pen.

(Lead-Off Question)

2. Ask, "In the next day or two can you determine if some parts of the root grow faster than others?"
3. The teams should record their observations in the best way they can. Perhaps they may want to make a scale drawing of the plant each day.
4. Ask, "Why have some of the marks moved farther apart than others?"



Root - 24 hours later

LESSON IX GROWING PLANTS WITHOUT SEEDS (Optional)

Concept: To distinguish new growth from old growth. To produce growth from plant parts, other than seeds.

Materials:

KIT	NON-KIT
None	Various plants

* There are many plants which can be grown without starting them from seed - philodendron, geranium, sugar cane, grapes, potatoes, coleus, onions, carrots, etc. In this lesson of work, the children can explore a wide variety of growth patterns from different plants. Have you ever thought of growing a pineapple?

Procedure:

(Lead-off Question)

1. Ask, "Do you have any plants at home that were started without seeds?"
   "Have you ever planted potatoes?"
   "Have you ever planted strawberries or raspberries?"
   "Have you ever seen asparagus planted?"
   "Can anyone bring plants to try?"

2. The children should be off and running. Don't stifle their discovery by telling them answers! Rather, continue to ask questions.

   "What changes have occurred in the plants?"
   "Are there signs of new growth?"
   "Where does the growth occur?"
   "How big is it?"
   "How fast is it growing?"
   "Can all plants grow new plants from part of the old one?"
   "Can we make a test with a potato to find out if any plant fragment will grow into another plant?"
   "What about a carrot?"
   "Have you noticed the eyes of the potato?"
   "What are they for?"

EVALUATION: What did my students learn?

Evaluation should always be directed at whether you have been successful in presenting concepts and processes to your children. When using an activity-based program, you should hold paper and pencil evaluating devises to a minimum. Observing your children is the most productive pattern as to whether the unit is successful or not. You might base your evaluation on answering the following self-questions. The following represent only a few, of many questions you might ask:

Did my children -

1. Learn how to plant plants?
2. Ask better questions?
3. Debate?
4. Observe better?
5. Measure?
6. Identify seeds by their plants?
7. Write better sentences?
8. Learn how to control variables?
9. Learn the uses of different bones?
10. Compare bone structures?
11. Work as members of groups?

Etc.

TEACHER'S RESOURCE BOOK

FOR

ATOMS AND MOLECULES

Grade 4

September 1978

Superintendent of Schools
Anchorage School District
4600 DeBarr Road, Anchorage, Alaska 99504
Telephone (907) 333-9561, Extension 231

A Program Development Division Production

ATOMS AND MOLECULES

Grade 4

KIT

35 pill boxes
35 screws
35 plastic containers (cup size)
17 plastic spoons
3 quarts vinegar
2 lbs. baking soda
35 magnifying glasses
2 balloons
70 straws
35 test tubes (18 x 150 mm)
17 stopper and glass tube apparatus
1 lb. calcium carbonate
17 splints
1 lb. calcium chloride
2 lbs. sodium carbonate (washing soda)
35 medicine droppers
1/2 lb. copper sulfate
1/2 lb. nickel sulfate
1/2 lb. sodium thiosulfate (hypo)
Data worksheet

NON-KIT

Paper and pencil
Pop bottle
3 jars for solutions

SUPPLEMENTARY MATERIALS

F-547	ATOMIC ENERGY: INSIDE THE ATOM
F-558	CONTROLLING ATOMIC ENERGY
F-3403	MATTER AND THE MOLECULAR THEORY
F-490	LAWS OF CONSERVATION OF ENERGY AND MATTER
F-491	LAWS OF GASES
F-557	PARTICLES OF MATTER
F-565	MATERIALS OF OUR WORLD

ATOMS AND MOLECULES

Grade 4

INTRODUCTION:

Chemistry is the study of the composition of matter, the properties of matter and the changes in composition of matter. Needless to say, your children do not have this understanding. More important, there is no reason why they should. However, they do know their world is made up of "stuff" and when you put "different stuff" together something new might be made. They have observed mixing "stuff" such as milk and flour; water and plaster of paris; a candle burning; the fizz when a bottle of pop is opened. These are all examples of matter undergoing change. In this unit of work the children will be asked to mix materials together and really look at what happens. From this experience they will gain early understandings of the things matter is composed of.

The unit is divided into 6 lessons which will allow your students to observe, collect data, discuss and begin to understand that matter (stuff) is made of small particles which cannot be individually seen, but can be worked with just the same. Your students will be able to relate changes in chemical and physical properties and, perhaps most important, will be involved in investigating science.

RATIONALE:

The conceptual threads promoted in this unit of work will be extended at grades 5 and 6. Your principal has the units, so if you want, feel free to take a look.

An understanding of (1) what matter is composed of and (2) what interaction exists between substances - hence, a conceptual idea of atoms and molecules is a slow process which must be taken with small concrete steps. The unit at grade 4 fills an important segment of the necessary sequence. Remember, we cannot see atoms, yet we know a great deal about them. We know this by hitting them together, mixing etc. and watching what happens. From this we infer their structure.

SCHEDULE:

Your involvement is with the children and not of handling materials any more than is absolutely necessary. The more you can promote student involvement in setting up - running - taking down the experiments, the greater the learning.

The unit is divided into 6 lessons which are designed to allow your children to observe, collect data, discuss and begin to intuitively understand the nature of matter. Each lesson will take 30-45 minutes to complete if you use a pre-laboratory discussion experimentation - post-laboratory discussion sequence. Leading questions are given throughout each lesson so that your children might be stimulated to do some additional experimentation. If you allow for the added discovery the unit of work will probably last the full three week request limit.

CAUTIONS:

You should caution your students that some of the chemicals they will use are POISONOUS and should not be put in their mouths. Have them handle everything as if it is poisonous and you should have no trouble. If they should spill some chemical on their hands they should go to the sink and wash it off with water. Newspapers on the student desks will be very helpful in controlling what spills there are.

BACKGROUND INFORMATION:

Now for some facts for you. These are included only as specific information to allow you to become more familiar with atoms and molecules. The information is not essential for the success of the unit!

PROPERTIES OF MATTER:

All materials have three characteristics: (1) they take up space (have volume, (2) they have weight, (3) they are all made up of atoms and molecules. All substances that have these three characteristics are called "matter". Wood, water, and air are all matter because they all take up space, have weight and are made of atoms and molecules. Because molecules have weight and volume, even though they are very small, matter also has weight and volume.

STATES OF MATTER:

Matter is found in three forms or states. These are solid, liquid and gas. A solid has a definite volume and shape of its own. A liquid has a definite volume but no shape of its own (it takes the shape of its container). A gas has no definite volume and no shape of its own. A liquid or a gas is often called a fluid, which is any material that flows.

MOLECULAR THEORY:

This theory contains four main ideas: (1) all matter is made up of molecules. (2) There are spaces between molecules, (3) molecules are always moving (4) molecules attract each other.

All matter is made of molecules and there are spaces between these molecules. The spaces between the molecules of a liquid are larger than the spaces between a solid. The spaces between the molecules of a gas are larger than those between the molecules of a liquid. It is hard to imagine spaces between the molecules of a solid, but if a piece of gold is put into a dish of mercury (silvery liquid), the mercury will go into the gold - the molecules of the mercury will slide in between the molecules of the gold.

Molecules are always moving. Each molecule in a solid vibrates around a fixed point. The molecules in liquids and gases move at random in all directions. The molecules in gases travel faster and farther than those in liquids.

Molecules attract each other. The force with which they do attract each other depends upon what kind of molecule they are, and also depends on how close they are to each other. Two molecules attract each other much more strongly when they are close together than when they are far apart. So molecules in a solid attract each other more strongly than those in a liquid, and molecules in a gas are so far apart they hardly attract each other at all.

ATOMIC THEORY:

This theory states that all molecules are made up of small particles called atoms, and atoms within a molecule attract each other very strongly.

The attraction between atoms in a molecule is much greater than that between molecules within a substance. For the attraction between atoms to be broken, a chemical reaction (accompanied with some form of energy) must occur.

SOLUTIONS AND SUSPENSIONS:

A solution is a mixture of two or more materials evenly mixed together whose particles are separate molecules. Most solutions are made by disolving a solid (solute) into a liquid (solvent), an example would be sugar in water. Some solutions are liquids in liquids (water in vinegar), gases in liquids (carbon dioxide in water or pop), and gases in gases (a mixture of oxygen, nitrogen and carbon dioxide). Solutions have three characteristics: (1) The particles of the materials are separate molecules and cannot be seen even with a powerful microscope. (2) The particles in a solution are evenly spread through all parts of the solution and will never rise to the top or sink to the bottom. (3) The dissolved material cannot be removed by filtering the solution. The material doing the dissolving is called the solvent. The material being dissolved is called the solute. If a material will dissolve in another it is said to be soluble. If it is not able to be dissolved in the other material (oil in water) it is said to be insoluble. Salt is soluble in water, but insoluble in alcohol. Salt is the solute if water is the solvent.

The molecular theory explains what happens when materials form solutions. When any material is dissolved, it separates into its molecules. At first these are fairly close together because they attract each other. But the molecules of the solvent also attract them. All the molecules keep moving and bouncing about. The molecules of the dissolved material spread into the spaces between the molecules of the solvent. After awhile, all the molecules become evenly mixed and stay that way. In a solution such as sugar and water, the particles of sugar are separate molecules. The solution is clear because the molecules are much too small to be seen. They are also small enough to pass through a filter that the water molecules will go through.

Why some materials are insoluble in other materials can also be explained by the molecular theory. There is very little attraction between molecules of oil and water. When oil and water are mixed, the oil molecules tend to stay together and do not spread among the water molecules. By strongly shaking such a mixture, you can separate the oil into tiny clumps of oil molecules spread through the water. But after the mixture is allowed to stand awhile, the oil molecules will attract each other and come together and form a separate layer.

ELEMENTS AND COMPOUNDS:

Every one of the many materials that we know about is different from every other material in one or more ways. Yet all these materials can be classified into three categories: ELEMENTS, COMPOUNDS, MIXTURES. An element is a material that cannot be changed into simpler materials by chemical means. It is made up of only one kind of atom and if broken down into smaller units would only yield parts of atoms (nucleus, electrons, etc.). There are just over 100 different kinds of elements which also means there are just over 100 different kinds of atoms. Iron, copper, carbon, gold, hydrogen and oxygen are examples of elements.

Materials are made of molecules which in turn are made of atoms. An atom is the smallest particle of an element that can exist as that element. For example, an atom of iron is the smallest particle of iron that there can be. A molecule of an element is made of one or more atoms of the same kind. Most elements have only one atom in the molecule. Some of these are iron, copper, aluminum, silver and carbon. So in these elements the atom and the molecule are the same. But in some elements that are gases, the molecules contain two atoms of the same kind. There are two atoms of oxygen in every oxygen molecule. Other examples are hydrogen, chlorine and nitrogen. These molecules are called diatomic.

A compound is a material made of two or more elements joined together, or combined so they cannot be separated unless a chemical reaction occurs. One way to tell the difference between an element and compound is to see if the material can be separated into two or more different materials. Some ways this can be done is to heat the material, run an electrical current through the material, or add some other substance to the material and cause a chemical reaction. An example is as follows: mercuric oxide is a compound of two elements, mercury (a silver-colored liquid) and oxygen (a colorless, odorless gas). When mercury and oxygen combine they form a red powder which is mercuric oxide. When the red powder is heated, it breaks up into its elements, oxygen is given off and mercury is left. Mercuric oxide and table salt (sodium chloride - NaCl) are made of two elements. Water (H_2O), hydrochloric acid (HCl) and carbon dioxide (CO_2) are also made of only two kinds of elements. Sugar, alcohol and acetic acid are compounds that each have three different kinds of elements in the molecules. Alum, baking soda and some soaps have four elements in them. And there are some compounds that have even more elements than just four.

Materials that are not elements or compounds are called mixtures. The molecules in a mixture are intermingled, but they are not chemically combined. Each element keeps its individual property. For example, in a mixture of iron filings and sulfur powder you can see the individual particles of iron and sulfur. If you pass a magnet through the mixture the iron filings will adhere to it. If you add water to the mixture the filings will drop to the bottom and the sulfur will float to the top. The parts of this mixture can be separated by physical means. If this mixture were heated, a chemical reaction would occur and the two elements would combine and form a completely different substance - iron sulfide, which is a black material that is not magnetic and will not float on water (its properties have changed from the original materials). The molecule of iron sulfide (which is a compound now) contains one atom of iron and one atom of sulfur (FeS). Air is a mixture of gases, milk is a mixture of fats, water, sugar and other materials, wood, paper, glass, and even your body is a mixture or a variety of elements and compounds.

PHYSICAL AND CHEMICAL CHANGES:

A physical change is a change in which the material changes its size or form but remains the same material with the same properties. The molecules of the material are not changed, only the form, state or shape of the material has changed. For example, water goes through physical changes when it turns to ice or steam, but the molecules of water remain unchanged.

A chemical change is a change in which one material is changed into one or more different materials with different properties than the original material had. The molecules of the first material are changed by a chemical reaction into different molecules.

An example of a chemical is the burning of sugar which contains carbon, oxygen and hydrogen atoms in the molecule. When energy is added in the form of fire or heat, a chemical reaction occurs and the molecule is split, leaving carbon in the form of charcoal and water vapor is given off.

LESSON I WHAT IS IT I'M THINKING OF?"

Concept: To identify an object by inference (a reasonable guess based on past experience).

To understand that matter can be described in terms such as phase, color, texture, shape, size, hardness, etc.

* A yardstick (ruler) or meter stick must be placed in a prominent place in your room several days before starting this lesson.

Materials:

KIT	NON-KIT
None	Ruler or Yardstick or meter stick

Procedure:

(Lead-Off Question)

1. Begin this lesson by suggesting to the class that you are going to play the "What Is It?" game. Ask "Can you name an object in the room that fits all of these clues.

   a. It is solid
   b. It has flat sides
   c. It has eight corners
   d. It is longer than this page
   e. It is narrower than this page
   f. It is hard
   g. It is smooth
   etc.

2. The class will probably want the clues repeated and will want to discuss each.

(Follow-up Question)

3. After the students have guessed the object as "Can you think of any other clues that might have been given to describe the object?" Possible answers include:

   a. Made of wood
   b. Can bend a little
   c. Cannot be stretched

4. This lesson can be continued with other objects individual students might select. The important thing to promote is the physical properties of each object.

5. As the students tire of this game you might move right into the Black Box exercise (Lesson II).

LESSON II BLACK BOXES

Concept: To identify an object by inference (a reasonable guess based on past experience).

* This lesson is used as the introductory lesson for each Atoms and Molecules beginning at grade 3. The lesssson is always fun no matter how many times it is run. A screw is used for grade 4 instead of a steel washer.

* Scientists are not able to see atoms and most molecules because they are too small, but they still are able to know how they look by the way they react with other materials.

* The "black box" method of inquiry is a good way for students to find out that even though they can't see many things, they can tell what they are like or, in some instances, what they are. The students do this by using their senses and relating what they sense to other things they know about.

* The entire atomic theory has been developed from inferences. The atom's structure is inferred from phenomena that can be observed very much in the same way that the identity of the hidden object (in this lesson) can be inferred.

Materials:

KIT	NON-KIT
35 pill boxes 35 screws	Paper and pencils

Procedure:

1. Before you begin this lesson check to see if one screw is in each pill box. There should be enough boxes so each student has one.

2. Pass out one box to each student. Caution the students not to open their box!

(Lead-off Question)

3. Ask, "Can you draw a picture of what is in the box?"

4. Indicate to your students that they can do anything they want to the box except (1) open it; (2) crush it; dip in water, etc.

5. Needless to say, the noise level in your room will rise for a time. Everyone will try to "shake it to pieces". LET THEM SHAKE! Soon the students will find they can't tell a thing when they shake the box vigorously. At this point suggest that they turn the box different ways.

6. The students may not know what a screw is, but they can probably draw a pretty good picture of the object. Have them draw what they think the object looks like.

(Follow-up Question)

7. After they have drawn their pictures ask:

"What pictures did you draw?"
"How many of you drew the same thing?"
"Can anyone describe the object?"
"What other things might you do to know what the object looks like?" - "Without looking at it?"
"Do you have to see every object to know what it looks like?"

8. This is a fun lesson and can be extended to any hidden objects in the pill box or a larger box. Perhaps your students will want to try some other materials. Practice in inferring is a valuable exercise.

9. Some properties you might try to stress are: (1) size, (2) shape, (3) hardness, (4) material composition, e.g., like metal, like glass, like rubber, like rock, etc.

LESSON III UP, UP AND AWAY

Concept:

To describe changes that occur during an experiment.
To identify changes as evidence of interaction.
To identify specific properties of different materials.
To observe signs of chemical change.

* The following lessons are divided as if requiring one class period each. You may find that one lesson runs right into the next.

* All materials used should be treated as if they are poisonous. Caution your students about ingesting any of the materials.

* The materials will be easier to handle if you put part in front of the room and another part in the back of the room. NEWSPAPERS ON DESKS ARE IN ORDER.

Materials:

KIT	NON-KIT
35 plastic containers	Paper and pencil
17 plastic spoons	Pop bottle
1 qt. vinegar	
2 lbs. baking soda (sodium bicarbonate)	
35 magnifying glasses	
2 balloons	

Procedure:

1. Students should be assigned to teams of two. Each team will need the following items.

   a. 2 plastic containers
   b. 1 plastic spoon
   c. small amount of vinegar (acetic acid)
   d. small amount of baking soda (sodium bicarbonate)
   e. small amount of water
   f. 2 magnifying glasses

(Lead-off Question)

2. Have each team obtain a spoonful or two of the white powder. This they can put in their empty plastic container. Ask "What are some things you can tell me about the white powder?" Elicit characteristics such as: color, smell, feel, (small amount) etc.

3. After the students have had a chance to discuss some of the characteristics of the material suggest that they do some other things to the material to find out about it. You might do this by asking "What would happen if you poured some water on the white powder?"

4. The white powder should be covered to a level approximately 1-2 inches.

5. Have the students stir the mixture and observe with their magnifying glasses.

* The sodium bicarbonate will not completely dissolve in the water. The students will observe that most of it settles in the bottom of the plastic container. Some "pieces" will float up and down in the water like snowflakes. The students can observe this with their magnifying glass.

(Discussion) 6. A discussion about what the children observed is necessary at this point. If you want the students to record their data, this can be done before the discussion.

(Follow-up Question) 7. Ask "What would happen if you poured some vinegar over the white powder?"

8. Very little vinegar is necessary!

9. Needless to say, the children will want to repeat this experiment. Let them!

* The children will observe that the more vinegar they add the more violent is the reaction.

(Discussion) 10. Focus attention on answers to the following questions:

"What happened when water and the white powder were mixed?"
"What happened when vinegar was added to the white powder?"
"Was a gas formed?" - "Were there bubbles of gas?"
"What kind of gas do you think was given off?"
Defer giving a direct answer - see Lesson IV.
"What happened when you added more vinegar?"

Demonstration: You might want to run a demonstration, showing the gas formed, at this time. You can do this by placing 4-5 spoonfuls of sodium bicarbonate in a pop bottle, adding vinegar and then placing a stretched balloon on top. The gas formed will inflate the balloon.

This demonstration should create new questions.

ATOMS AND MOLECULES

GRADE 4

NAME ______________________________

SYMBOLS KEY: $\uparrow$ = gas $\downarrow$ = precipitate or settled material

$\rightarrow$ = yields

LESSON NO.	WHAT I DID:	WHAT HAPPENED?	WHAT WAS THE FINAL RESULT?
	I mixed:		
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________
	____________	____________	____________

LESSON IV WHAT ARE THE BUBBLES?

Concept: To identify the composition of a substance.

* The children will certainly want to know what kind of gas was liberated in the baking soda-vinegar reaction. Defer giving a direct answer.

* The children may have already learned that when they breathe in they take in oxygen and when they breathe out they give off carbon dioxide.

* The children will be blowing into lime water with a straw. Caution them about sucking up the solution!

Materials:

KIT	NON-KIT
35 plastic containers	Paper and pencil
35 straws	
35 test tubes (18 x 150 mm)	
17 stopper and glass tube apparatus	
1 qt. vinegar	
2 qt. lime water (calcium carbonate)	
2 lb. baking soda (sodum bicarbonate)	
17 splints	

Procedure:

1. Students should be assigned to teams of two. Each team will need:

   a. 2 plastic containers
   b. 2 straws
   c. 2 test tubes
   d. 1 stopper and glass tube apparatus

(Lead-off Question)

2. Say, "Do you remember the reaction that occurred when you put the white powder and vinegar together?" "What do you think the gas was?"

3. After the students have had the opportunity to discuss what the gas was, suggest that there are some ways to find out what it was for sure.

4. Have each team obtain about two inches of the Calcium hydroxide (lime water) in one of the plastic containers. Once the teams have the solution at their desks they then should divide it equally by pouring half into the other plastic container.

5. Next suggest to the students that they blow GENTLY into the solution, using the straw. They should continue blowing until they observe something happening.

* The liquid appears cloudy. If they let the solution set, the white material will eventually settle to the bottom.

CO_2	+	$Ca(OH)_2$	$\longrightarrow$	$CaCO_3$	+	H_2O
carbon dioxide		calcium hydroxide		calcium carbonate		Water

(Follow-up Question)

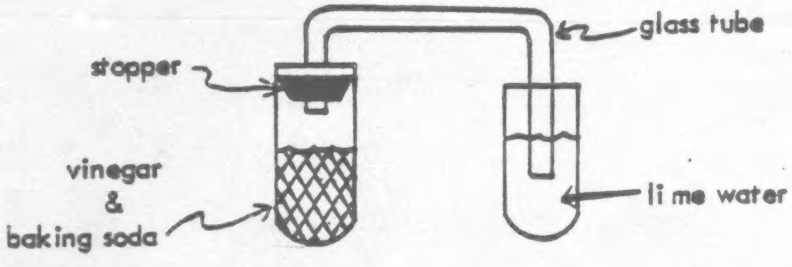
6. Ask, "What comes out of your mouth when you breathe out?" "Was the solution cloudy with white particles before you blew into it?"

   "Would you say that whatever happened had something to do with what you breathed out through the straw?"

* If everything fails, you may have to suggest that carbon dioxide comes out of our mouths when we breathe out.

7. Next ask, "If the gas we breathe out is carbon dioxide and this turned the solution cloudy, how could we check the gas that was given off with the white powder-vinegar reaction? - Hopefully, the children will suggest bubbling the gas into lime water.

8. The apparatus to bubble CO_2 from the baking soda-vinegar reaction is shown below. Instruct the teams to fill one test tube 1/2 full of lime water. In the second tube, add a small amount of white powder. Next, add a small amount of vinegar and place the glass tubing apparatus in this tube and place the other end in the lime water. YOU SHOULD DEMONSTRATE THE GENERAL PROCEDURE. DON'T PUT THE VINEGAR IN THE BAKING SODA WHEN GOING THROUGH THE DEMONSTRATION SINCE THIS WILL RUIN THE DISCOVERY THE CHILDREN WILL SEE BY DOING IT THEMSELVES.



* The limewater will turn cloudy in this experiment. The limewater turned cloudy when the students blew through the straw into it. Carbon dioxide is given off when you breathe out. Therefore, carbon dioxide is probably what is causing the limewater to turn cloudy.

9. Another experiment which your students may want to run to confirm that the bubbles of gas are carbon dioxide. Some of these are listed below.

   a. Place a spoonful of baking soda in the plastic container. Add vinegar, but do not stir. Place a card over the top of the container and wait a few seconds. Now the upper portion of the jar will contain carbon dioxide. Insert a burning splint. The carbon dioxide extinguishes the flame.

(Discussion) 10. The broad concepts you have dealt with in this lesson are:

   a. When a new substance was formed it was always the result of at least two other substances reacting.

   b. The characteristics of the new substance formed was very different from those of the substances from which it was formed.

   c. Not all substances react together to form new substances.

   d. Tests can be devised for determining the nature of new substances formed.

LESSON V FALLING SNOW

Concept: To describe changes that occur during an experiment.
To identify changes as evidence of interaction.
To observe signs of chemical change (formation of a precipitate).

* You may want to have your students take data for Lesson V, VII, etc. One possible data sheet is shown below. This can be copied on the board or duplicated for each student.

* Before beginning this lesson, make up a strong solution of Calcium chloride for the class. To mix a strong solution of $CaCl_2$ you will need to fill a container (approximately 1 pint) with water. Next add $CaCl_2$ until no more material will dissolve. If you let the material settle, you then can pour the clear liquid off to be used in the experiment.

* Make a strong solution of washing soda (Na_2CO_3) in a like manner. Washing soda is slightly different than baking soda ($NaHCO_3$) both react in the same way but Na_2CO_3 will work better in this experiment.

* Other solutions will be needed, as shown, in later lessons. They can be prepared as those described above.

Materials:

KIT	NON-KIT
1 lb. calcium chloride	Data worksheet
1 qt. lime water	
1 lb. sodium carbonate (washing soda)	
1 qt. vinegar	
35 test tubes	
35 medicine droppers	
35 straws	

* The reaction occuring in this experiment is:

$$CaCl_2 + Na_2CO_3 \longrightarrow 2NaCl + CaCO_3 \downarrow$$

(added to) (yields) (precipitate or settled material)

LESSON V FALLING SNOW (continued)

WORKSHEET

LESSON	MIXTURE	PRECIPITATE COLOR	TIME TO FORM
V	Calcium chloride + washing soda		
	Limewater + breath		
VI	Copper sulfate + washing soda		
	Sodium Thiosulfate + vinegar		
	Nickel sulfate + washing soda		

Procedure:

1. Students should work in teams of two. Each team should have the following:

   a. 2 test tubes
   b. 2 droppers
   c. small amount of Calcium chloride solution
   d. small amount of washing soda (Na_2CO_3) solution
   e. small amount of Limewater
   f. small plastic containers and straws
   g. vinegar

(Lead-off Question)

2. Ask, "What do you think might happen is you mixed equal amounts of these two solutions together?"

3. Tell students to mix and observe what happens.

* A white precipitate will form when the two solutions have been mixed together.

4. Refer students to the experiment where they blew through a straw into limewater solution. Ask, "Do these precipitates appear similar?" HAVE STUDENTS SET THE SOLUTION AND PRECIPITATE ASIDE! SAVE!

5. Suggest that there might be a way to find out.

6. Have students obtain a small amount of clear limewater and again blow into the solution until it becomes cloudy.

7. Have students set this solution aside so the white material can settle.

* You might want to stop the sequence at this point for a time!

8. After the precipitates have had a chance to settle to the bottom of the containers have the students carefully pour off the liquids into the sink.

9. Next, four or five dropperfuls of vinegar are added to the precipitates. Students should observe the reactions carefully.

* Bubbling should occur and the precipitate should dissolve.

* The reactions the students have performed are:

I. a.

$CaCl_2$	+	Na_2CO_3	————	2NaCl	+	$CaCO_3$
calcium chloride		washing soda (sodium bicarbonate)		salt (sodium chloride)		calcium carbonate (white precipitate)

b.

$CaCO_3$	+	CH_3COOH	————	$(CH_3COO)_2$	+	CO_2	+	H_2O
calcium carbonate (white precipitate)		vinegar (acetic acid)		calcium acetate		carbon dioxide (bubbles)		water

II. a.

$Ca(OH)_2$	+	CO_2	————	$CaCO_3$	+	H_2O
calcium hydroxide (lime water)		carbon dioxide (from breath)		calcium carbonate (white precipitate)		water

b.

$CaCO_3$	+	CH_3COOH	————	$(CH_3COO)_2Ca$	+	CO_2	+	H_2O
calcium carbonate (white precipitate)		vinegar (acetic acid)		calcium acetate		carbon dioxide (bubbles)		water

10. Remember, it is not so important that the students be able to write the chemical reactions for the preceeding experiments. It is important, however, for them to: (1) describe the changes that occurred, (2) identify these changes as evidence of stubstances interacting and (3) observe the changes as possibly being due to chemical change.

LESSON VI QUICK CHANGE

Concept: To describe changes that occur during an experiment.
To identify changes as evidence of interaction.
To observe signs of chemical changes.

* The following series of chemical reactions are a continuation of the patterns established in Lesson V. They are included here to reinforce the ideas already established. It is probably best if you make the chemical available to the teams of students and let them experiment!

* Strong solutions of copper sulfate, nickel sulfate and sodium-thiosulfate solutions can be made prior to class by filling approximately 1 pint container with water. Next add the chemical until no more of it will dissolve. Then pour off the solution for use.

* See Cautions - page 2.

Materials:

KIT

35 test tubes
15 medicine droppers
Copper sulfate
Nickel sulfate
Hypo (sodium thiosulfate)
Washing soda (sodium carbonate)
Vinegar
Calcium chloride

NON-KIT

Water
3 jars for solutions

Procedure;

1. Pair of students measure 4 dropperfuls of the copper sulfate solution (POISON) into one test tube, and 4 dropperfuls of washing soda solution into another test tube. Add one to the other and observe. They should see a blue precipitate form immediately.

2. Using clean test tubes, 4 dropperfuls of vinegar is added to 4 dropperfuls of hypo solution. A white precipitate should form immediately.

3. Four dropperfuls of washing soda solution is added to 4 dropperfuls of nickel sulfate solution. A light green, "curdish" precipitate should form immediately. The students next add 4 dropperfuls of vinegar and the precipitate should dissolve. This reaction is reversible. If washing soda is now added, the precipitate forms again, and vinegar will again make it disappear.

4. Enter the results on the worksheet.

LESSON VI QUICK CHANGE (continued)

* The reactions the students will perform are:

a. $CuSO_4 + Na_2CO_3 \longrightarrow CuCO_3\downarrow + Na_2SO_4$

Copper sulfate	sodium carbonate (washing soda)	copper carbonate (blue precipitate)	sodium sulfate

b. $CH_3COOH + Na_2S_2O_3 \longrightarrow CH_3COONa$

Acetic acid (vinegar)	Sodium thiossulfate (hypo solution)	sodium acetate (white precipitate)

c. $Na_2CO_3 + NiSO_4 \longrightarrow NiCO_3 + Na_2SO_4$

Sodium carbonate (washing soda)	Nickel sulfate	Nickel carbonate (light green precipitate)	Sodium sulfate

* The following reactions will react more slowly:

5. Using clean test tubes, pairs of students add 4 dropperfuls of copper sulfate solution to 4 dropperfuls of calcium chloride solution. They should shake the mixture gently for a few seconds and set it aside where they can observe it while they go on to the next activity. A white precipitate should form within 5-20 minutes.

6. Four dropperfuls of copper sulfate solution is put into a clean test tube and four dropperfuls of hypo solution is added. The change in color to the yellow-green of the mixture is an immediate indication of a chemical change, but the mixture will probably have to be left standing overnight for the students to be able to see the yellow precipitate.

7. The results can be entered on the worksheet as they are available. Most of the students can probably see the precipitate from number 5 above by now.

* The reactions the students perform in steps 5 and 6 are:

$CuSO_4 + CaCl_2 \longrightarrow CuCl_2 + CaSO_4$

Copper sulfate	Calcium chloride	Copper chloride	Calsium sulfate

OPTIONAL DEMONSTRATIONS:

There are two demonstrations you may want to work in during the time you are working with the unit. Materials are available at our supply center in the service center building. If you drop by we can supply you with the materials needed. Both of the demonstrations are fun to do.

A. Bouncing Mothballs.

3/4 cup of baking soda is dissolved in a gallon jar which is 3/4 full of water. Slowly add a cup of vinegar and bubbles of carbon dioxide should form in the jar. Drop in a few mothballs which should repeatedly rise to the surface and fall to the bottom. If this doesn't happen, or stops after a short time, then additional amounts of baking soda or vinegar might be added to get the formation of bubbles. The mothballs become coated with a layer of the forming bubbles, which floats them to the surface where the bubbles escape into the air. The mothballs are now too heavy and sink to the bottom to begin the cycle anew. Be sure the lid is off the jar.

B. White Clouds

This will show the formation of a precipitate from two gases. One cotton wad hung on a paper clip is dipped in ammonia, and another is dipped in diluted hydrochloric acid. They are hung on opposite sides of a beaker. A piece of paper or cardboard can be laid on top as a loose lid. A white cloud will form and eventually white crystals will be deposited as the precipitate forms. A window should be open somewhere in the room. The reaction is:

HCl	+	NH_4OH	$\longrightarrow$	NH_4Cl	+	H_2O
Hydrochloric acid		Ammonium hydroxide		Ammonium chloride (white cloud)		Water

EARTH SCIENCE: ROCKS

GRADE 4

EARTH SCIENCE: ROCKS

GRADE 4

KIT

Crushed granite
17 pieces granite
35 magnifying glasses
35 probes
15 samples each of:

- anthracite
- white marble
- kaolinite
- hematite
- magnetite
- pink feldspar
- pink sandstone
- pink marble
- limestone
- biatite
- obsidian
- pumice
- gray sandstone
- galena
- graphite
- shale
- slate
- quartz
- calcite
- white feldspar
- talc

15 nails
15 streak plates
15 magnets
2 plastic containers, 16 oz. and covers, 3 3/4 inch
1 LP burner
1 125 ml. Erlenmeyer flask
6 clear glass marbles
1 bag of sand
1 test tube holder
15 plastic containers, 4 oz. and 2 1/2" covers
15 paper cups
15 spoons
1 bag gravel
1 bag of clay
1 bag of plaster of paris
16 red sponge sheets
16 yellow sponge sheets

NON-KIT

Chalk
2 rocks per student

SUPPLEMENTARY MATERIALS LIST:

FILMS:

F-963	ALASKA EARTHQUAKE
F-137	EARTHQUAKES AND VOLCANOES (1957) - 14 min.
F-223	GLACIERS (1960) - 14 min.
F-552	FINDING OUT ABOUT ROCKS (1961) - 14 min.
F-831	WHY DO WE STILL HAVE MOUNTAINS - 20 min.
F-1019	ROCKS THAT FORM ON THE EARTHS SURFACE - 16 min.
F-1067	ROCKS THAT ORIGINATE UNDERGROUND - 23 min.
F-1447	MOUNTAINS - A FIRST FILM - 9 min.
F-43	UNDERSTANDING OUR EARTH: ROCKS AND MINERALS
F-279	UNDERSTANDING OUR EARTH: HOW ITS SURFACE CHANGES
F-435	ROCKS AND MINERALS
F-902	ROCKS AND THE RECORDS

UNITS:

UN-116	ROCKS AND MINERAL COLLECTION AND GEOLOGY MODELS
UN-124	EARTHQUAKES
UN-151	GEOLOGY

BOOKS:

JUNIOR SCIENCE BOOK OF ROCK COLLECTING - Crosby
ROCKS AND MINERALS - Zim
WHAT IS SOIL - Syrocki
STONES AND MINERALS - Follett Series
SOIL - Follett Series
ROCKS AND MINERALS - Follett Series
OUR PLANET EARTH - Follett Series
STORIES READ FROM THE ROCKS - Parker
THE EARTH - A GREAT STOREHOUSE - Parker
ROCK COLLECTING - Crosby
WHITMAN LEARN ABOUT BOOKS -
    a. ROCKS AND WHAT THEY TELL US
    b. OUR EARTH, WHAT IT IS
THE STORY OF ROCKS - Shuttlesworth
THE FIRST BOOK OF STONES - Cormack
THE WONDER OF STONES - Gans
THE JUNIOR SCIENCE BOOK OF ICEBERGS AND GLACIERS - Lauber
ALL ABOUT VOLCANOES AND EARTHQUAKES - Pough
HOW AND WHY WONDER BOOK OF OUR EARTH - Suttom

EARTH SCIENCE

Grade 4

INTRODUCTION:

The lessons in this unit have been written so that your students will be able to carry out experiments with simple materials - rock specimens, nails, hand lenses, and draw conclusions based on their observations of the experiments.

It is based on the idea that children will achieve more when they become involved in the experiment. They will be able to see for themselves that certain results occur when simple experiments are performed.

At times, throughout the unit, you will want the students to proceed individually and at their own speed. At other times you will want the whole class to work on the same activity.

The lessons are designed to allow your students to follow many side paths for experimentation. For example, when you reach questions about characteristics of rocks, you may wish to let your students explore several ideas besides the activities mentioned in the unit. Your schedule and the student's interest should be the only limits to this kind of creative work.

You will probably find it best to divide your class into working groups of two. This arrangement will enable the students to work and converse easily as they discover new things. This arrangement will allow you to become a "Classroom Manager" rather than a source of all information. You will be free to move from group to group, encouraging the students to answer their own questions by experimentation.

Teachers who have used a discovery approach to teaching have found it important to have four points well in mind before beginning each lesson:

1. Lead-Off Questions
2. Follow-up Questions
3. Activities
4. Discussion Questions

If you can proceed with these ideas you should find the unit of work exciting for both you and your students.

Student pictures, data tables, reports, talks are all part of student involvement for this unit. It is important to blend together the activities of each lesson with these reporting techniques.

SCHEDULE:

The 6 lesson unit has been designed to take from 5-10 hours depending upon the maturity of the students and whether you choose to do the optional activities. It should be run over a three week period of time. The time period could be broken into 45 minute periods, two or three times each week. Using the 45 minute pattern will allow enough time for your students to explore their ideas. Because some of the activities relate to rocks found outdoors you may want to schedule this unit when the ground is free of snow.

TEACHER BACKGROUND:

Collections! Everyone collects something...coins, stamps, match boxes, old automobiles, gum wrappers. It is with this desire to collect that we take advantage of in this unit of work. Rocks are among the things students like to collect...sorting, classifying, grouping and regrouping according to their standards.

This unit of work tries to get your students to look closely at various objects. It tries to get your students to find specific characteristics of rocks and to classify according to a set of rules. BECAUSE OF THE GRADE LEVEL, NO DISTINCTION IS MADE BETWEEN ROCKS AND MINERALS IN THE UNIT.

The shape of the United States has changed many times since the solid shelf (granite) which forms its base first appeared above the waters of the earth. In past ages there has been a continual raising and lowering of the land masses. Evidence of this is seen by finding rocks and plants and animals which could only have been formed under the oceans. Yet, beneath these same mountains are the eroded remains of older ranges that were even higher in their time. The earth's crust is a dynamic and everchanging surface.

Three major causes have created the major changes on the earth's surface. These causes are Diastrophism, Volcanism, and Erosion. These are defined as follows:

1. DIASTROPHISM - Changes in the land of great areas of the earth. It included all movements of solid parts of the earth with respect to other parts.

2. VOLCANISM - This includes all the phenomena that are connected with molten rock and its movements, e.g. volcanoes.

3. EROSION - Gradation is another word to describe erosion. It is the wearing away of the solid surface of the earth.

As in all subjects, certain phenomena must be described and classified. So it is in the study of the earth. The rocks of the earth have been described and classified into groups. Three major groupings have been established. They are:

1. IGNEOUS ROCKS - Rocks which have solidified from magma (molten material) whether originating below or above the earth's surface. Most of the rocks on the surface of the earth are igneous rocks.

2. SEDIMENTARY ROCKS - Rocks of this type are composed of small particles of older rocks and other materials. If igneous rocks make up about 95% of the earth's surface, then about 5% of rocks on the surface are sedimentary. However, since they generally occur very near the surface of the earth we generally see them in greater frequency.

3. METAMORPHIC ROCKS - Rocks which have been formed by altering the properties of older rocks. They can be formed from both igneous and sedimentary rocks.

Finally, rocks are largely composed of minerals. These are naturally occurring inorganic (without carbon) crystalline substances which have definite physical and chemical properties.

Major Concepts:

Several concepts are important to the general understanding of earth science. These are:

1. By examining rocks, some of the earth's history can be surmised.
2. One property of all rocks is hardness.
3. Many different materials make up the surface of the earth.
4. Rocks can be worn away by freezing, grinding, dissolving.
5. Change takes place continually - sometimes rapidly - sometimes slowly.
6. Rocks are formed by sedimentation, evaporation, heat and pressure (generally a combination of one or more).

MOHS SCALE OF HARDNESS

1 - talc
2 - gypsum
3 - calcite
4 - fluorite
5 - apatite
6 - orthoclase
7 - quartz
8 - topaz
9 - corundum
10 - diamond

A rough approximation of hardness can be made by using fingernail, copper penny, knife or nail, and glass.

1 - Soft, greasy flakes of material will be left on fingers.
2 - Can be scratched easily by fingernail.
3 - Can be cut easily by a knife or nail; just scratched by a copper coin; not scratched by a fingernail.
4 - Can be scratched by a knife or nail without difficulty but not easily cut.
5 - Can be scratched by a knife or nail with difficulty.
6 - Cannot be scratched by a knife or nail; can be scratched by a file; will not scratch ordinary glass.
7 - Scratches glass easily.
8 - Not often used.

LESSON I   ROCKS ARE EVERYWHERE

Concept: To classify rocks into groups.

Materials:

KIT	NON-KIT
Crushed granite Granite pieces 35 magnifying glasses 35 probes	Paper and pencil

* You might want to make up a storyline for this experiment... Something like, "On a recent trip to the moon you picked up some rocks to bring back. However, you found the rocks weighed too much. So you decided to crush the rock and bring back one of each kind of material found in the rock. This is the material....

Procedure:

1. Pass out the white paper, magnifying glasses and probes to each student. Pour a small amount of crushed granite into each students paper.

(Lead-Off Question)

2. Ask, "How many really different pieces can you find?" You might want to separate into different piles.

3. Move about the room helping the students make the separation. Most students will make several material piles of the same thing. You will need to help at this point.

4. After the students have had the opportunity to separate the material into different piles, begin the descriptive part of the lesson.

5. Ask, "How many really different piles of material did you get?" (Normally there are between 7 and 13 different materials).

6. Next ask your students to describe their material piles. Put the descriptive words on the chalkboard. The list should include descriptive words like: brown color, shiny, metallic, glass-like, white, clear, sharp. Needless to say you may have to put a word on the board and ask if anyone has that material.

7. Next, pass out a piece of granite to each student, ask, "Who can give me a description of this rock?" Put the words on the chalkboard. (Make sure the description is broad and less specific than for the small pieces.)

(Discussion Question)

8. You now can discuss the difference between the two lists of descriptions and end the lesson by noting that the more specific we describe something the better others will know what we are talking about.

9. Review this by having the students raise their hands if they have a pink rock or a brown rock. Show that the large piece of granite was called pink in the general description.

10. BE SURE TO RETURN THE CRUSHED ROCK TO THE CONTAINERS!

LESSON II CHART MAKING

Concept: To classify rocks into groups according to their properties.

Materials:

KIT

35 magnifying glasses
17 samples each of:

- anthracite
- white marble
- kaolinite
- hematite
- magnetite
- pink feldspar
- pink sandstone
- pink marble
- limestone
- talc
- obsidian
- pumice
- gray sandstone
- galena
- graphite
- shale
- slate
- quartz
- calcite
- white feldspar
- biotite

17 nails
17 streak plates
5 bar magnets

NON-KIT

Paper and pencil
White writing chalk

* This lesson is divided into various tests the students can do to classify rocks into groups. Each group should explore the various test, hence the activity will take several days.

* In the first part of lesson II you can introduce Chart Making as a mystery game. After the students see the pattern of activity, put them on their own with each test.

Procedure:

1. Remind the students that they have already begun classifying rocks by color (Lesson I).

2. Pick out four rocks by colors. "white and black"

3. Draw the following on the chalkboard:

A	
B	
C	
D	

FIGURE 1

LESSON II CHART MAKING (continued)

(Lead-off Question)

4. Show the class the four rocks. Tell the class they will have to ask you for clues in placing the samples on the right letters.

5. If the students ask you to tell them the color of each rock, draw a line on the chart and write colors as shown.

	COLOR
A	White
B	Black
C	White
D	Black

	COLOR	FEEL	LUSTER
A	White	Smooth	Dull
B	Black	Slippery	Shiny
C	White	Sandy	Shiny
D	Black	Smooth	Dull

FIGURE 2

6. At this point the white and black rocks can go into two different places. Therefore, more clues are necessary.

7. Depending on the rocks you chose, ask them to decide on another clue. For example:

   layers vs. no layers
   sandy vs. smooth
   dull vs. shiny

8. As the clues are asked for, draw more lines on the chart (see FIGURE 2).

9. Using this technique for one or two clues, should allow you and your students to group the rocks.

10. Once the students have the idea of Chart Making, they can begin experimenting with the tests shown below.

    a. HARDNESS TEST

    Some rocks are harder than others. Using a nail your students can group according to hardness. Some rocks will scratch others. Rocks can be grouped this way.

    b. STREAK TEST (Anthracite, Slate, Shale)

    Certain rocks can mark. Your students can find the ones which will mark on paper. Next, they can find which rocks mark on the streak plates. Certain rocks such as slate and shale are hard to distinguish without a streak test.

c. COLOR TEST

All rocks have color. How many different color groups are there?

d. TEXTURE TEST

Some rocks are smooth. Others are rough. Others are sandy. Have the students classify by how the rocks feel and look.

e. ACID TEST (Quartz, Limestone, Kaolinite, Calcite, White Marble)

Some rocks react to acid. Vinegar is used for this test. The white chalk you have in your room may or may not react with vinegar. If it is high in calcium carbonate, it will.

f. MAGNET TEST (Galena, Magnetite, Hematite, Shale)

Some rocks will be attracted to a magnet.

g. ELECTRICITY TEST (Optional)

If you have batteries, bulbs and wire around you might have your students see if any rocks conduct electricity. Some will.

11. The final step will be to draw a master chart, on chalkboard or railroad board, showing all the properties of rocks the students agree on!

12. Please assist us in serving our other classes by carefully sorting the rocks. Thank you.

LESSON III THINGS ARE BREAKING UP

Concept: To understand that rock can be broken into smaller parts by abrasion, freezing water, and rapid heating and cooling.

Materials:

KIT	NON-KIT
2 plastic containers, 16 oz. and covers, 3 3/4 inchs	2 rocks per student
1 LP Burner	Water
1 125 ml. Erlenmeyer flask	
6 clear glass marbles	
1 bag of sand	
1 test tube holder	

* Ask each student to bring two rocks (that they can easily hold in their hand) from home or from recess on the playground.

** The day before beginning this lesson, prepare the frozen water demonstrations shown below. Place in school freezer.

a. Put some sand in one of the plastic containers. Shake gently to settle it evenly over the bottom. Gently add water until there is about one inch of water above all the sand. Put it in the freezer. The lid is not necessary.

b. Fill the other plastic container to the brim with water and carefully put on the lid, trapping as little air as possible. Put a little tape in several places to help hold the lid. Put it in the freezer. When it freezes, the expanding ice should push or tilt the lid up.

*** The LP Burner, 125 ml. flask, test tube holder and marbles for the rapid heating and cooling demonstration (Step 5) should be set up before the lesson. Some icewater in the container will help, as well as a chunk of ice.

Procedure:

1. Using the two rocks they brought in, (don't use rock samples in kit) have the students rub the pieces together over a piece of paper for about two minutes. Tell them to be careful not to grind their fingers! Find out how many found that some of the rock wore off and fell on the paper. (For those who didn't, have them trade one of their rocks with someone else.) Have them repeat the rubbing using different parts of the rocks. Ask them to compare the rock particles with the rocks to see if they seem to be the same. Some will probably find the particles are all from only one of the rocks and may be able to relate it to the hardness test of Lesson II. Some will probably also note the smoothing of the rubbed places.

Ask the class where rocks might be ground together like this. You will particularly want to discuss river and seashore grinding of rocks and the rounding and smoothing of the rocks, also glacial action.

2. (Send someone to bring the ice demonstrations.) Tell the class how you made the bar of ice. Take it out of the container and show them the sand frozen in one side. Put it on a desk top (clear ice down) and demonstrate how easily it slides around. Turn it over (sand side down) and ask the class how they think it will move now. Have someone push it around with one finger. They should be able to hear a grinding noise and see a jerkiness of movement. Increasing pressure on the ice will increase the sound and perhaps scratch the desk. Tell them that huge masses of ice (glaciers) can hold rocks (just like the ice bar holds the sand) and can grind and wear away large amounts of rock.

3. Show the class the plastic jar of frozen water and explain how you prepared it. Ask them what seems to have happened. They should be able to see that the "water got bigger when it turned to ice" and that is pushed or tilted the lid up. Discuss with the class the breaking of rocks when water gets into cracks in the rock and then freezes, relating it to the expansion of ice just seen. This kind of rock breaking is of major importance in high mountains.

4. Let the class briefly examine the marbles to see that they are not filled with tiny cracks. Put the marbles into the flask, attach the holder, and start heating them. Discuss what might happen if the hot marbles are suddenly dumped into the cold water. When someone suggest they will crack or break—ask what would cause that. The idea that a rapid change of temperature would do it should be fairly clear now. Dump the hot marbles directly into the cold water. In about 30 seconds they should be cool enough to handle and the class should again examine them. If the temperature change was great enough, there should be tiny cracks all through the marbles, or even some broken marbles (be careful of cuts in this case). Remind them that now water can get inside the marble, freeze, and finish breaking them up. This is another kind of rock breaking of major importance in high mountains.

5. Perhaps some of the students will want to do this experiment at home or at school: soak a rock in a dish of water for about an hour. Pour the water out. Put the dish with the rock in the freezer overnight.

LESSON IV LAYING IT DOWN

Concept: To understand the ways sedimentary rock is formed.

Materials:

KIT	NON-KIT
15 hand lenses	Water
15 samples of shale	
15 samples of sandstone	
15 plastic containers, 4 oz. and covers, 2 1/2 in.	
15 paper cups	
15 plastic spoons	
1 bag of sand	
1 bag of gravel	
1 bag of clay	
1 bag of Plaster of Paris	

* Each pair of students should have a hand lens, a sample of shale, a sample of sandstone, a 4 oz. plastic container with lid, a paper cup, and a stirring spoon. If you don't have water in your room, have a container of water ready.

** Write SEDIMENTARY ROCKS on the blackboard and, under it, indented, write SHALE, and SANDSTONE.

*** Have the bags of clay, sand, gravel, and Plaster of Paris opened on your desk so the students can get their spoonfuls of each one under your guidance (or it can be passed out to them at their desk if you prefer).

Procedure:

1. Most of the class has probably seen mud, sand, or clay particles being carried along by moving water such as rivers, streams, etc. Maybe they saw evidence of this in Lesson I. Discuss with them what happens if the moving water runs into a lake or the ocean and slows down: that is, the dropping of the carried material (sediments), heaviest particles first. Use the word SEDIMENT, and underline that much of the term SEDIMENTARY ROCKS on the blackboard so that they can better understand it.

2. Have the students put two spoonfuls each of clay, sand and gravel in their 4 oz. plastic container, put the lid on, shake it vigorously, then set it down and examine it carefully to see if the material is evenly mixed, or in layers. Have them shake and examine it once more to see if the results are the same. Be sure they hold the lid on with a finger as they shake the container!

3. Now add enough water to cover the materials in the container. Try to avoid having too much water. Again have the students replace the lid, shake and examine the materials. The formation of layers should be quite obvious. Have them repeat the shaking and examination.

4. Ask the students to pour the material from the container into the paper cup. Put three spoonfuls of Plaster of Paris in each cup and have the students mix the material thoroughly with their spoons. After they are thoroughly mixed, set them aside for the hardening. Should some be spilled, and harden, it can later be easily softened and removed by moistening it.

5. Now have the class study the sample of shale. Ask them if they can find layers in the rock and, by looking at the grains with the hand lens, what they think the rock was formed from (clay). Now have them compare the piece of shale with their rock descriptions in the hardness list.

6. Repeat above, with the sample of sandstone. (It was formed from sand cemented together.)

7. Perhaps by now the cup of material has hardened enough to remove it from the cup. Test it with the tip of a pencil. If it seems hard enough to hold together, have any excess water poured off. Then have the students turn the cup upside down and slap it on the palm of their hand. The chunk of material should fall out onto their palm (cut or tear away the cup if it doesn't). Have them immediately place it on a piece of paper towelling to finish drying (it is still fairly soft). They have made their own sedimentary rock! They cemented rock particles together in much the same way they are cemented together under the surface of the earth. Ask them to compare the samples of shale and sandstone with the layers in "their rock". Some should notice that "their rock" is upside down (since the heaviest rock particles should be on the bottom) and will turn it over.

8. After the material has thoroughly dried, perhaps it can be broken vertically so that each one of the pairs of students can have a specimen to keep himself.

LESSON V THE HOT ONES

Concept: To understand the ways metamorphic and igneous rocks are formed.

Materials:

KIT	NON-KIT
35 hand lenses	Water
17 nails	Clay
17 4oz. plastic containers	Glass of water
17 of each of the six rock samples	
17 samples of pumic	

* Write METAMORPHIC ROCKS on the blackboard and, under it, indented, write SLATE and QUARTZITE.

** Write IGNEOUS ROCKS on the blackboard and, under it, indented, write GRANITE and LAVA (PUMICE).

Procedure:

1. Review quickly that Lesson IV showed that one way sedimentary rock is formed is by the cementing together of rock particles. See if they can find and hold up the one that was formed from clay or mud (shale), and the one that was formed from sand (sandstone).

2. Now ask the class what might happen to shale (have them examine the shale) if it is pressed together a lot harder, and heated (but not melted). The kind of answers you'll look for here are: made harder, cemented harder, grains pushed closer together, etc. If they have trouble understanding heat without melting, have them rub the palms of their hands together briskly. Ask them to find the rock sample that looks like it was once shale, but was changed by great heat and pressure. Have them test it with the nail to see if it is harder than shale. Point out on the blackboard that this is the metamorphic rock called slate.

3. Do the same with the sample of sandstone (matching it with the quartzite).

4. Make it clear that metamorphic rocks are rocks that have been changed by great heat and pressure (but not melted).

5. Continue by pointing out that if the heat and pressure are so great that the rock is melted, we now have a different way that rocks are formed - the igneous rocks (indicate the name on the blackboard). Ask the class how or where rock might get hot enough to be melted. Some will probably suggest the center of the earth, and volcanoes - so you can probably get them to combine the two with the idea that melted rock from a volcano comes from deep within the earth.

6. Of the two remaining igneous rock samples, perhaps many of the students will recognize granite from past experience. Ask them to put the other igneous rock (pumice) in their containers of water. Explain that this kind of lava cooled so rapidly that it trapped many bubbles of gas. Sometimes there are so many bubbles that the rock floats on water! Ask them to look to see if the pumic is fine-grained (with hand lens) indicating rapid cooling. Granite is a large grained rock since it cooled slowly. Have them compare the two.

LESSON VI THE BENDS

Concept: To understand some of the ways that land is lifted and mountains are formed.

Materials:

KIT	NON-KIT
16 red sponge sheets	None
16 yellow sponge sheets	

* Each pair of students should have one yellow and one red sponge sheet, and a yellow and red crayon to color the layers.

Procedure:

1. Review with the class that the last few lessons have shown that rock is constantly being broken into smaller parts in many ways, and that the small rock parts are again made into solid rock by cementation, heat and pressure. Remind them that the layers in the sedimentary rock they made (Lesson IV) were flat. Tell them that they are now going to do something to try to find out how the flat layers of rock in the earth's crust can be tilted or even raised up into mountains.

2. Have the students trace around a sponge (making 4 traces) on a piece of paper.

3. Have them put the red sponge sheet on top of the yellow one and lay them on top of a pencil. Have them slowly lift the pencil about an inch. Ask them to look at the edge of the sponge sheets and draw a picture of what they see. Have them draw only the sponge layers, and then color the layers on the first trace.

4. Have the students put two books on their desk far enough apart so that just the ends of the sponge layers rest on the books. Have them put the sponge layers on the books, supporting the center with a pencil to keep the layers level. Demonstrate it with the extra sponge layers. Have them slowly lower the pencil, finally removing it. Ask them to draw and color what they see (sponge layers only) on the second trace.

5. Ask them to lay the sponge layers flat on their desk and, with hands on each end, press together gently. Demonstrate. Have them again draw and color the sponge layers in the third trace.

6. Now have them put more pressure on each end of the sponge layers. Ask them to draw and color the sponge layers in the fourth trace.

7. Have them look at trace #1 and ask them to describe what happens to rock layers if the crust of the earth is pushed up. Have them cover half of trace #1 with a hand, and ask them to suppose that a river has worn away the rock layers that they have covered up. Ask them to describe the rock layers that are left.

8. Have them study trace #2 and describe what happens to rock layers if the crust of the earth sinks under them. Ask them what might make the crust sink, to try to bring out the idea of the tremendous weight of the rock layers themselves.

9. Have them study trace #3 and trace #4 and describe what happens to rock layers if they are pushed from both sides. Ask them if they can think of any examples of these kinds of uplift. The Olympic and Cascade Mountain Ranges were formed in these ways (by folding).